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FOOD PRODUCTION AND LAND UTILIZATION

A DANGEROUS situation appears to be developing in world fobd production. Almost everywhere populations are increasing, and in many regions the area of land available for food production is shrinking: agriculturists are being faced with the problem of producing more and more food from less and less land. The population of England and Wales has gone up by about 14 millions since 1891, but the area of land under field and crops has shrunk by nearly 4 million acres. We now have little more than half an acre of cultivated land per head of population, and it required about 1·6 acres per head to produce the pre-war dietary. Our present reduced scale of feeding, with its cut of about 20 per cent of calorie supply, calls for less land per head, but even so we are producing on our present acreage only 40 per cent of our food. And the area of cultivated land still shrinks: housing estates, road widening, surface mining, demands of the Services and other activities absorb much land and often spoil more. Of the land still left in cultivation, little more than half can be called good; the rest is only moderate, and although we still have some reserve of potentially utilizable land, the cost of reclaiming it and keeping it in cultivation would be high, often very high. At the present rate of loss, we shall be fortunate if technical advances in agriculture enable us to continue producing as much as 40 per cent of our food, unless the public will tolerate a lower dietary.

So long as Britain was the chief buyer in the world's food markets, we had a considerable voice in fixing the price; but there are now other buyers, and the commercial arrangements are different; prices have moved against us and may rise still further. Europe (excluding the U.S.S.R.) was formerly almost self-supporting in food, importing less than 10 per cent of the grain consumed and having a small net export of meat and dairy produce. Now, however, the position is entirely different: the import requirement of grain is more like 20 million tons to satisfy the reduced—in many cases drastically reduced—rations now available. In so far as this situation is due to war devastation, one can hope that before long it will be remedied.

A new problem, however, is just beginning to emerge. It has already appeared in India and may soon appear elsewhere. Until recently India was practically self-supporting in food; there was, indeed, an export of wheat and of oil seeds, but also an import of rice. But, thanks to efficient health services organised by devoted British workers, the population has risen rapidly and enormously: in 1931 it was 338 million, but by 1941 it had increased to 389 million. It has now outstripped the present food-producing capacity of the land. India has ceased to export food and has begun to import it. Until recently the growth of world population was mainly met by bringing new land into cultivation; the late Sir Daniel Hall calculated that each new head of population in Great Britain brought into use an additional 2–2½ acres of land, the yields being

lower than ours. Much virgin land was still available and easily utilizable. But that kind of land is now all taken up. A great deal of what remains will need large and costly development schemes to make and keep it productive. Unfortunately, too, as in Great Britain, much of the land that has been brought into cultivation has been lost, partly through the same causes as operate here, but largely through another cause from which happily we do not suffer greatly, namely, soil erosion. This has been particularly destructive in the rather dry regions well suited to wheat, and in the wet tropics where lie our largest reserves of potential food-producing land. Prof. C. B. Fawcett has estimated that the area of potentially cultivable land in the world is about 10,000 million acres. (H. L. Shantz's quite independent estimate is higher—17,000 million acres—but includes all land under a 'crop climate', while Fawcett has eliminated mountains and other areas physically unsuitable for cultivation.) About half of this may be regarded as fairly workable. The world population is estimated at something more than 2,000 millions and increases at the rate of 20–25 millions per annum. There appears, therefore, to be about 2½ acres of fairly workable land per head—but constantly shrinking while the population constantly increases. Prasolov estimates that about 10 per cent of the land surface of the world is already cultivated, that is, about 3,600 million acres, 1·8 acres per head.

Britain is for its size the most crowded country in the world, and the most dependent on outside sources of food. We are therefore vitally affected by this fact of decreasing available land and increasing demands upon it. To a large extent the situation is outside our direct control, but under the very able and energetic guidance of Sir John Boyd Orr, the Food and Agriculture Organisation has striven to arouse recognition of the urgency of the problems among all nations.

We can, however, try to do something in Britain itself. It is clearly essential that the remaining soil resources of the nation should be carefully assessed and that the destruction of food-producing land should be halted. Unfortunately, 'planning' has not been conspicuously successful in this direction. Perhaps some better procedure may be evolved, but in the meantime methods of evaluating different soils are being elaborated. This is by no means a simple matter, for soils, climate, and management are so interlocked in food production that it is impossible to express any of them numerically. Soils can, however, be grouped, and two methods have been adopted for doing this. One is by soil analysis. This has hitherto been used chiefly for indicating fertilizer and lime requirements, and for that reason was long subordinated to the advisory section of the county agricultural activities; only recently has it been given an independent status. Large numbers of analyses have been made, but few have been adequately discussed in publications generally available; this defect will, it is hoped, be remedied in time; but meanwhile, methods are continuously under review, and fuller knowledge of the soil factors involved in crop production is being gained. Much good work done in other countries is now available; the most recent summary is contained in the new edition (the fourth) of M. Demolon's well-known treatise "La Dynamique du Sol"; American, Canadian, Australian, Russian and other work has been collated and described by the Commonwealth Bureau of Soil Science.

The other method of evaluating soils is frankly empirical but of great practical value. It is based on their performance in the use to which they are actually put, and it necessitates accurate surveys to discover that use. Agricultural surveys, of course, have long been carried out in Great Britain; the most complete were those made by the first Board of Agriculture in the early years of the nineteenth century, which still remain unequalled. In recent years agricultural officials have collected a great mass of information which has been statistically summarized in the "National Farm Survey of England and Wales" (1946), a most useful publication which provides students, experts and officials with much valuable information, and would have been even better if the parallel survey for Scotland could have been made on the same lines and for the same period, so that the results could have been strictly comparable. It has, however, little descriptive detail, and one could wish that, having collected the material, the Ministry would issue a series of volumes comparable with the old ones. Another survey, more restricted in scope, but more homogeneous in execution, was made of the grass lands of Britain by Sir George Stapledon and his colleagues. The fullest land utilization survey yet made in Britain was carried out under Prof. Dudley Stamp and is discussed below. It is the outcome of much valuable study by British geographers which has not yet received the recognition it deserves, but which has revolutionized geographical science in Britain and has furnished a solid foundation on which a sound scheme of land utilization can be built up. The need is great, and time is pressing.

THE LAND OF BRITAIN AND HOW WE USE IT

The Land of Britain

Its Use and Misuse. By Prof. L. Dudley Stamp. Pp. viii+507. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 42*s.* net.

BRITAIN has been fortunate in its geographers. As soon as the subject emerged from the purely descriptive to the more scientific stage, the need was realized for detailed studies of the land to find out the uses to which it was being put, and to discover, if possible, why a particular use was adopted. Among the pioneers were H. J. Mackinder who, in his classical work "Britain and the British Seas", discussed the marked differences between the uplands and lowlands of Britain; and H. R. Mill who, in a paper before the Royal Geographical Society, prepared a specimen description of a 1-in. Ordnance Survey map sheet. But it was Patrick Geddes who gave definite form to the idea of setting out the principles

on which a survey should be based: starting with a small area and studying it intensively. The idea was taken up with alacrity by teachers of geography throughout Britain: under the wise guidance of H. J. Fleure, they formed themselves into the Geographical Association, which co-ordinated the methods and arranged for periodical discussions and exhibitions of work. In the various colleges and university departments of geography, students were trained in the methods of detailed survey, the pioneers including besides H. J. Fleure, James Fairgrieve, Profs. Eva G. R. Taylor, C. B. Fawcett, S. W. Wooldridge, Dudley Stamp, S. H. Beaver and others. The Le Play Society, founded by Patrick Geddes to carry on the work of the French geographer Le Play, has through its able and energetic director, Miss Margaret Tatton, arranged for its members to make similar studies in various European countries, and these have furnished wider experience and new ideas. Quietly and unobtrusively a large number of surveys were made by the students and staffs of university departments, but owing to absence of means of publication most of them remained only in manuscript. Nor was the work confined to the universities: it penetrated to the schools and it gave a reality and vividness to the teaching of geography that the subject had never had before. Even village schools took the matter up, and some admirable local studies were made.

Those who had seen something of the work and had had an opportunity of studying some of the resulting maps and reports could not help regretting that so much valuable work should lie unappreciated and inaccessible to many to whom it would have been helpful and interesting. The task of collecting and co-ordinating it seemed well-nigh impossible of achievement. Fortunately, Dr. L. Dudley Stamp, on his appointment as Sir Ernest Cassel reader in economic geography at the London School of Economics, realized the great possibilities and was undaunted by the difficulties; he proceeded from 1929 onwards to develop a scheme for a unified survey of Great Britain—acre by acre, every field—to be based on the 6-in. Ordnance Survey Map. The results are published in nine volumes and a series of 1-in. maps, and they furnish a remarkably full record of the land utilization of Britain before the War: they contain much new and valuable information that the busy student would not easily find, and Prof. Stamp has had the happy idea of preparing this summary volume which includes the leading results and gives references to the relevant volumes of the complete survey.

One of the unexpected generalizations that emerges is the steadily increasing part that natural geographical factors play in determining land use, contrary to the general idea that science emancipates mankind from dependence on natural conditions. Interesting examples are given in the chapter on orchards, where the importance of a proper site, especially in relation to late frost, is well brought out. Were it not for its liability to frost, the Wisbech area could, the author states, supply all Britain's requirements in cooking apples; as it is, only a small proportion is grown. It might be thought that practical men would have known this themselves—and, of course, the best of them do—but the surveyors found a surprisingly large number of badly sited orchards, including much of the fruit planted in the eastern counties during the difficult 1930's. Nothing can now be done to improve them.

Market gardening is known to require a light soil and a water-table fairly near the surface; proximity to a steady market is an obvious advantage. The housing developments near London, however, have involved so much drainage that the water-level has fallen and the suitability of the land has therefore lessened. Overhead irrigation has largely met this difficulty, but naturally makes its heaviest demands on water in times of prolonged drought when water supplies are lowest. Supplies of town stable manure and of town refuse used to be important factors in determining the location of market gardens but are so no longer. Nor does the distribution of population much affect the distribution of market gardens, but rather the steadiness of the demand for produce: determined by such factors as freedom from spells of unemployment.

The effect of transport on land utilization is well brought out. The area east of Canterbury was formerly not easily accessible; now, however, motor lorries readily penetrate, and fruit-growing and market gardening have both greatly increased. The author thinks that other regions at present rather inaccessible might similarly be opened up: he mentions some of the outer Hebrides, which have a high average temperature, much sunshine, low rainfall and sandy soils, and might be well used for some types of cultivation.

A final section records the finances of the Survey, and one can only regret that so valuable a piece of work should have had to be so largely paid for by Prof. Stamp himself, a situation that surely calls for recognition. Meanwhile, the book can be cordially commended to all interested in the land of Britain.

E. John Russell

BRITAIN'S SCIENTIFIC WAR EFFORT

Science at War

By J. G. Crowther and R. Whiddington. Pp. vi + 185 + 51 plates. (London: H.M. Stationery Office, 1947.) 2*s.* 6*d.* net.

In a foreword to this popular account of how science helped the armed forces to win the War, Sir Henry Dale explains that the object of the Scientific Advisory Committee to the Cabinet in securing approval for the preparation of this work was "to make available to the public an authoritative account of some of the more important aspects of the scientific contribution to the war effort, based on official archives, but so written as to be acceptable to the reader without special scientific education". Naturally, the whole field of the scientific war effort cannot be covered in a single volume, and the authors have chosen radar, operational research, the atomic bomb, and science and the sea, because of their wide interest, as typical illustrations. All four are essentially British contributions.

The purely scientific basis of radar had been established before the War; but it was the initial foresight of Dr. H. E. Wimperis and Mr. A. P. Rowe, the inventive genius of Sir Robert Watson-Watt, the timely brilliant production of the cavity magnetron by Prof. J. T. Randall and Dr. H. A. H. Boot, and the close collaboration of scientific workers, military users and industrialists, which first saved us from aerial destruction and then allowed us to attack the

enemy with deadly accuracy. The story of radar will perhaps be told in more detail elsewhere, but certainly not so vividly as in "Science at War".

Operational research owed its inception to Mr. A. P. Rowe, then superintendent of the Telecommunications Research Establishment. It is concerned with the study of weapons, tactics and strategy, and the methods which were developed in war-time can be employed, in peace-time, in industry. It is interesting to learn that the first consistent exposition of the principles of operational research was given by Prof. P. M. S. Blackett.

The section on the atomic bomb is the first adequate exposition of the British contribution to the discovery of the atomic bomb and the release of atomic energy. It is good to be reminded that British men of science were the pioneers in nuclear research, and that up to 1941 Britain led the world in this sphere of fundamental research and development. The huge task of the production of the atomic bomb, a remarkable achievement in itself, had to be left to the United States. Mr. Crowther and Prof. Whiddington content themselves and their readers by confining their story to events before the commencement of the American project.

Finally, in "Science and the Sea", we are told how Asdic works, how the magnetic and acoustic mines were defeated, and all about depth-charges and frog-men.

The book is a remarkable half-crown's worth. Not only is the subject-matter presented in an exceedingly interesting fashion, technical and scientific accounts being given in a manner that even those with little technical knowledge can easily follow, but, in addition, the volume is profusely illustrated by numerous line drawings and excellent photographs. If only some of our scientific text-books were as well provided!

S. WEINTROUB

EMPIRES IN TRANSITION

Colonial Policy and Practice

A Comparative Study of Burma and Netherlands India. By J. S. Furnivall. Pp. xiii+568. (Cambridge: At the University Press, 1948.) 36*s*. net.

Soviet Economic Development since 1917

By Maurice Dobb. Pp. vii+474. (London: Routledge and Kegan Paul, Ltd., 1948.) 18*s*. net.

THE history both of the U.S.S.R. and of the colonial territories of European States illustrates the impact of the ideas and activities of the West upon less-advanced peoples, and these two books together provide material for a comparative study which is of particular interest at the present time.

The historjan of the future is likely to find less cause for wonder at the changes that have taken place in Britain's imperial position in the last few years than at the fact that that position was ever achieved at all. The century of expansion which seems now to be closing has been, indeed, a remarkable period, and its final effects can no more be estimated yet than can those of the Bolshevik Revolution. Mr. J. S. Furnivall, who has already given us a notable study of Netherlands India, here takes one part of the story, the occupation of Burma, and endeavours to see it, not only as a part of the British achievement, but also, in a wider setting, as an illustration of the clash of cultures. In order to do this he has, in effect, combined several books in one. Of his 550 pages some two hundred are devoted to a survey and critical appreciation of British rule in Burma, and a further sixty to a summary of the material already made available in "Netherlands India". These two descriptive sections are followed by a long and valuable comparative study of British and Dutch policy, in which some comparisons are also drawn with conditions in Africa. Here Mr. Furnivall is, as he admits, "treading on uncertain ground", and the points he makes are largely drawn from the writings of Lord Hailey. Finally, there is what amounts to a political pamphlet, a discussion of current problems, with proposals for their solution. "If one would understand colonial practice", Mr. Furnivall writes, "one must study it both comparatively and historically", and it is "as a contribution to such a study" that the work is intended.

A full survey of colonial government must await the pen of another Toynbee; but Mr. Furnivall has done much to clear the ground in one part of the world. What he says of Burma elucidates a situation that was already serious before the War and that came to a head under the Japanese occupation. But it does more, for Mr. Furnivall is concerned primarily to show that British rule in Burma, like Dutch rule in Netherlands India, arose as the result of economic and political forces; that the differences between British and Dutch policy reflect differences in the aims and conditions of existence of the two peoples. The British, with their respect for law and individual activity, tried to establish a system which would leave free play within a system of order; the Dutch from the first intervened much more directly and sought to mould society, while protecting it as far as possible from the pressure of economic forces by the development of social welfare.

The British method would seem to have failed, for it led, as Mr. Furnivall shows, to "the disintegration of social life through the inadequacy of law to control the working of anti-social economic forces". How far this disintegration had gone in corruption and lawlessness he makes only too clear, and in the preface, written some time after the rest of the book, while approving the recognition of Burmese independence as wise and bold, he feels that "it is impossible to contemplate the future without misgivings". Yet he hopes that Burma's need of help, and a sounder view on our part of our mutual interests, may enable us still to assist in the development of the country; and in his earlier book he has indicated his reasons for believing that the introduction of the "invigorating principles of Western social life" is perhaps "the best justification of European intervention in the East". There has certainly been no lack of ideals, though as Mr. Furnivall shows, in colonial affairs "the lofty aims of policy are continually frustrated in their practical application".

Underlying the whole work, however, is a criticism of colonial rule as such, which finds fullest expression in the following passage: "Contact with the outer world should furnish new sources of inspiration and enrich native social life, art and religion. But the people are not brought into contact with the outer world except in the sphere of economics; they remain imprisoned in a dying civilization and their social life is impoverished and not enriched." This would seem to be the view of the intellectual leaders of both Burma and Netherlands India. Whether, given the opportunity now presented to them, they can

achieve more, remains to be seen. Theirs is the task of reshaping society under the pressure of developments outside their own control.

How the task has been tackled in another society is the theme of Mr. Dobb's book, and the picture of a revolutionary *élite* successfully remoulding Russia and its Eastern territories emerges with the utmost clarity from his pages. The ground has been covered before, notably in Dr. Baykov's "Development of the Soviet Economic System", but Mr. Dobb has given flesh to the bones of Dr. Baykov's study, and produced a work which will have a wide appeal.

The first part surveys the situation before 1917, and the second is a careful study of the development of the Soviet economic system from the Revolution to the end of the Second World War, while the final four chapters contain an analysis of certain aspects of that system in practice. The aim of the book is clearly indicated in its title. Here is a survey of Soviet economic development since 1917: it is not, and is not intended to be, a critical appraisal, nor does it move beyond the range of economic policy, or attempt to estimate, in human terms, the results of the Soviet achievement. Under present conditions such an attempt could scarcely be made, for we are compelled to rely on Soviet statistics and declarations of policy, and cannot, therefore, calculate the significance of the actual achievement for other less advanced peoples of the world. It would be valuable to have more records of the type of Mr. John Scott's "Behind the Urals" (to which Mr. Dobb does not refer), but that we shall have no more of these for some years seems certain. Yet some indication of the conditions under which the Soviet system has worked is given by Mr. Dobb. Thus, in speaking of the difficult early years, he says "A more developed country can afford to brave uncertainty and to learn by trial and error, where a poorer country can bet only on a certainty". Given that this is true, we may ask who decides on the certainty, and how, and who settles the "given canon of social policy" referred to on p. 11, while we recognize that these are also questions that must be asked of colonial administrations.

Underlying the whole study, indeed, are the peculiar conditions—of geography, history, political and social development, resources, and something intangible in the very nature of the people—which have made possible the Soviet experiment (and, in another context, the British Empire). Mr. Dobb feels the force of these conditions, and especially the influence of the last-named, when he writes: "Many have marvelled that men and women could possess the endurance to do such things. . . . No mere heady propaganda or iron hand, but only a rare spirit forged in a people by its history, a boundless faith in their own ability to wring achievement from the future, is capable of inspiring men to endure and to strive as the Russian people have done".

Mr. Dobb is confident that Russia's experience has something of value to offer to the development of other parts of the world, and he makes some stimulating suggestions. But how great, in fact, Russia's direct influence will be we may well wonder, though the force of the Soviet idea is not to be doubted. Taken together, these two books are a valuable commentary on present problems.

It remains to be added that Mr. Dobb has provided useful maps and an index that is worthy of the name. Mr. Furnivall's index and single map are, unfortunately, unworthy both of his book and of the price at which it is published.

MAURICE BRUCE

A DESCENDANT OF BENJAMIN FRANKLIN

Alexander Dallas Bache, Scientist and Educator, 1806–1867

By Merle M. Odgers. (Pennsylvania Lives.) Pp. vii + 223. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1947.) 15*s*. net.

As the sub-title—"Scientist and Educator"—suggests, this is a biography of one whose influence and work not only enriched science, but also had a profound effect on educational development in the United States. In fact, in the words of Rear Admiral Leo Otis Colbert, the present director of the U.S. Coast and Geodetic Survey, Bache was "one of the great personalities of nineteenth-century America". This man of wide interests was the grandson of a Yorkshireman, Richard Bache, of Settle, and the great-grandson of Benjamin Franklin; it is not surprising that he took such an interest in the development of science and education in Europe.

The book gives an interesting account of Alexander Bache's many-sided activities—his classical education, his training as a cadet at the United States Military Academy, West Point, his European tour during 1836–38, and his activities as head of the Philadelphia Central High School and finally as superintendent of the United States Coast Survey, a post which he held from 1843 for a period of some twenty years. On leaving the Army in 1828, Bache had been appointed professor of natural philosophy and chemistry in the University of Pennsylvania, and in addition to teaching he found time for research and for participating in the activities of learned societies. It was, however, his election as president of Girard College that widened his interests in education and led to the tour through Europe to gather information of methods and institutions. Stephen Girard, merchant and banker, had died in 1831, and in accordance with his will the College was to provide a sound education including a variety of subjects—literary and scientific—and with special reference to "a pure attachment to our republican institutions, and to the sacred rights of conscience". This set a wide horizon to Bache's inquiries abroad, and although he did not ultimately become president of Girard College, his European tour, which included visits to nearly three hundred schools, provided ample material for educational research and forged a valuable link between the Old World and the New.

With regard to his scientific work, the earlier part of Bache's career revealed a great interest in terrestrial magnetism. During the two years that he was abroad, several observations were made by means of portable instruments, and an interesting list of recording stations, varying from Westbourne Green, in London, to the summit of the Faulhorn near Grindelwald, is given on pp. 124–25. Plenty of scope for scientific research was afforded by Bache's appointment as director of the Coast Survey, and after fifteen years work the verdict of the president of the Royal Geographical Society was that though the Americans were last in the field, they had leaped into the very first rank. Apart from survey of the coast, Bache was responsible for detailed study of the Gulf Stream; nor did he neglect geomagnetism. His numerous contributions to learned societies included a paper in the *Monthly Notices of the Royal Astronomical Society* on a new

method of observing transits. In the defence of Philadelphia in 1863 Bache played his part in the Civil War, but never recovered from the strain that it entailed.

It is a welcome sign that books of this nature appear from time to time on both sides of the Atlantic. Too frequently the achievements of science have been separated from their background of history and human endeavour. The author is to be congratulated in maintaining a vivid interest in Alexander Bache—the man and his times. There are numerous extracts from original sources and an exhaustive bibliography is appended. H. D. ANTHONY

SCIENTIFIC MANAGEMENT

Time Study and Common Sense

A Critical Study of some Conceptions and Methods with Suggestions for Improvement. By Abraham Cohen. Pp. viii+112. (London: Macdonald and Evans, 1947.) 10*s.* net.

Skill and Management

By G. E. Milward. Pp. x+102. (London: Macdonald and Evans, 1947.) 8*s.* 6*d.* net.

"TIME Study and Common Sense" is a disappointing book. Mr. Cohen explains in his preface that it consists mainly of lectures given to "Time Study engineers" at Royal Ordnance factories. It may be that the book lacks some of the author's personal exposition which may have made his arguments clearer in the lecture room than they are in the book. There is so much misunderstanding and misrepresentation about time study, and so many rather ponderous text-books have been published about it, that a new examination in the light of common sense would have been especially welcome. It is very much to be regretted that Mr. Cohen's work adds nothing but a vague confusion to the subject.

The book is mainly devoted to a rather scathing denunciation of a number of authors of books on time study. Mr. Cohen brings little evidence to support his attacks, and such standard authors as Barnes, Hendry and Carroll scarcely need fear comparison with this unhelpful book.

One or two quotations which are typical illustrate the quality of Mr. Cohen's thought: on p. 5 he states, "a Time Standard is a vague conception", and a little later, a time standard is defined as "some potential output which our workers are supposed to achieve". This is vagueness indeed, but it is wholly of Mr. Cohen's importation.

The main theme of the book is to discredit the method of rating work, and the addition of rest allowances which are almost universally used in time study in Great Britain. Yet this is what Mr. Cohen tells us to do on p. 52 in the chapter on "How to Set a Time Standard": "we should remember that we have to rate the recorded time up, or to rate it down, to a time we consider to be the optimum at which we want and expect our workers to work all the time—on an average". It is to be hoped that time-study men in Royal Ordnance factories found some better basis for their ratings than this.

There is a list of other works on time study at the end of the book, but no subject index.

It is perhaps a pity that the author of the above book did not follow some of the admirable and workmanlike advice given by Mr. Milward in "Skill and Management" upon the way in which the results of an investigation should be presented in writing. This book is a brilliant little work of close and coherent reasoning. Although it is primarily written for the specialist in management, it is safe to say that it could be read with profit and interest by anyone who wishes to keep in touch with modern thought on organisation.

Early in his book, Mr. Milward makes a point of great relevance to current industrial conditions when he analyses the difference between 'effectiveness' and 'efficiency'. The modern tendency towards more and more functional specialization increases the effectiveness with which separate limited ends are pursued, but it is accompanied by a growing difficulty in maintaining managerial efficiency in the broad sense. But, writes Mr. Milward, "effectiveness of performance cannot be expected to survive loss of managerial efficiency for very long".

In addition to its original contribution of some hard, straight thinking, this very well-balanced book quotes freely and appropriately from some of the classical economists and philosophers. J. LEIGH

GAS TURBINES

Modern Gas Turbines

With Special Reference to Stationary, Aircraft, Locomotive and Marine Types and to the Supercharging of Internal Combustion Engines. By Arthur W. Judge. Pp. xi+311+19 plates. (London: Chapman and Hall, Ltd., 1947.) 28*s.* net.

THE published information on gas turbines is both voluminous and widely dispersed, a considerable part of the technical literature of Britain, the United States, Switzerland, Sweden and other countries having been devoted to this subject in recent years. The object of this latest of Mr. Judge's books appears to have been to collect together at least the most important of these articles and papers, and to offer explanations and comments. It is a pity that this worthy object should be marred by several fundamental errors in thermodynamics, such as the statement in Chapter 3 that the efficiency of the Carnot cycle ". . . can also readily be shown to be represented by the following relations:

$$E = 1 - \left(\frac{1}{r}\right)^{\gamma-1}, \quad . \quad . \quad . \quad (10)$$

where r is the ratio of volume V_0 at 0 to V_1 at 1, i.e., the isothermal compression ratio". It is well known that the isothermal compression ratio has no influence whatsoever on the efficiency of the Carnot cycle, and that r in the equation should be, using the notation of the text, "the ratio of the volume V_2 at 2 to V_1 at 1, i.e., the adiabatic compression ratio".

In the same chapter, the same expression is derived for the efficiency of the Otto cycle and for the constant-pressure cycle. These expressions are correct as they stand, but, no note having been made to the contrary, leave the reader with the impression that all three cycles amount to very much the same thing, which is far from the case.

Far more serious, however, is the confusion which appears to exist in the author's mind on the subject

of entropy. On p. 62 the following statement appears: "The entropy of a given quantity of gas is defined as the ratio of its total heat to its absolute temperature. Thus, Entropy $\varphi = H/T$, where H = total heat reckoned from a given datum level, e.g., absolute zero, and T = absolute temperature". This is a misconception of the first magnitude which must be pointed out, as this book is likely to come into the hands of students whose imagination has been fired by the rapid development of the gas turbine, and whose knowledge of thermodynamics may not be sufficient to detect such errors. There are other errors in the text which make the chapter on thermodynamics unreliable.

However, the book improves when the author confines himself to descriptive work, the chapter on aircraft propulsion being very well done and containing some excellent illustrations.

It seems a pity that more emphasis was not placed on the vast difference between the aircraft gas turbine on one hand, and the land or marine gas turbine on the other. The design of the latter type of machine is a much more difficult proposition than that of the former, both because of the thermodynamic problems involved in converting the kinetic energy of the jet into useful work, and the metallurgical problems involved in finding materials to withstand the working temperatures, not for 500–1,000 hours as in the case of the aircraft turbine, but for ten to twenty years.

The book could serve a useful purpose if some of the errors, particularly in the chapters on thermodynamics, were corrected. One of the most useful features is the bibliography containing eighty-nine references.

E. G. Sterland

CHEMICAL ENGINEERING

Chemical Engineering Fundamentals

By Chalmer G. Kirkbride. (McGraw-Hill Chemical Engineering Series.) Pp. xi+419. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 30*s*.

THE intention of this book is to enable students with little knowledge of chemistry and mathematics and none of physical chemistry to begin the study of chemical engineering, or rather of what are termed "the five technical fundamentals". It opens with a chapter on human relations in chemical engineering; the next deals with "Useful Mathematical Tools". This is followed by "Important Concepts of Physics and Chemistry"—in fifty pages. Of these it might be said that never were so many facts (sometimes not strictly accurate) compressed into so few pages. The effect of reading this part of the book is one of bewilderment and a feeling of agreement with a statement made later that "dogmatism usually irritates most readers". It is doubtful if British students, who are trained to think rather than absorb facts, could take in all that is presented, or if it would be of any value to them if they did. They might well gain the impression, for example, that there are five important aromatic compounds represented by well-drawn formulæ, one of which, styrene, is used to make synthetic rubber. Whether it is a solid, liquid, or gas is apparently immaterial, as are its chemical reactions, other than polymerization.

Apart from this too intensive matter, there are many features in the book which are original and of much value to the discriminating teacher. The chapters on material balance, energy balance, static equilibria, dynamic equilibria and economic balance (though what balances in this case is not clear) are by no means elementary and contain numerous illustrative examples. The first and last chapters, on human relations in chemical engineering and the presentation of technical reports respectively, deal with subjects now recognized as of vital importance and, if not taken too literally, may be read with great advantage not only by teachers but also by those actually engaged in industry. The fifty pages of appendix with fifteen tables and twenty-nine graphs might have been more usefully devoted to the explanation of some of the statements in Chapter 3.

H. E. Watson

RIVERS—A NATIONAL HERITAGE

Our Rivers

By J. W. Kempster. Pp. xi + 300 + 21 plates. (London, New York and Toronto: Oxford University Press, 1948.) 25*s*. net.

LIFE in Great Britain, while not at first sight greatly influenced by rivers, in actuality is very profoundly affected by them. At one time the rivers were far more than a convenient means of disposal of sewage, and there is an increasing deepening of interest in the restoration of the rivers to something like their pre-industrial condition. Government departments which are greatly interested in these matters include the Ministry of Agriculture and Fisheries (with wide interests in fishing and in the irrigation of farm lands), the Ministry of Health (which watches zealously those rivers which are used for water supplies to the public), the Department of Scientific and Industrial Research (which is interested in water pollution research, and also in the hydraulics), the Ministry of Transport (on account of inland transport, water power, and the dangers of pollution from tarred roads), and many others. Obviously the subject is one that is important to the engineers of towns and cities and to civil engineers in general in relation to land drainage.

The author of this book has dealt comprehensively, if briefly, with all aspects of the matter. As an angler he holds that migratory fish are the best judges of pure water, and he commences by dealing with the life-history of salmon and sea trout. As a natural development he then takes up the subject of obstructions in the rivers, and devotes a chapter to river management, and another one to pollution. There follow several chapters dealing with legislation affecting rivers, and these appear to be of very great value as they cover the activities of the various bodies entrusted by Parliament with the management and control of rivers; and the over-riding Acts of Parliament are summarized. Fifteen appendixes give a mine of varied information in compact form.

The author is an enthusiast on the subject of improvements in the rivers of Britain. He regards them as a national heritage, and seeks to enlist interest and support towards conserving their utility, natural beauty and enchantment. The book is commended to all who are like-minded.

A. T. Doodson

Canada

A Study of Cool Continental Environments and their Effect on British and French Settlement. By Prof. Griffith Taylor. Pp. xiv+524+8 plates. (London: Methuen and Co., Ltd., 1947.) 25*s*. net.

A STUDY of the geography of Canada was much needed by students, who have little access to any objective consideration of that country. Prof. Griffith Taylor has supplied this want in great measure. The book is based on extensive travels in many parts of Canada and also in Newfoundland, which is included in the volume. Part 1 treats of the position, discovery and general physical features, including climate; part 2 considers the Dominion by natural regions; part 3 is a study of environments as related to man—a careful consideration of occupations and population problems. The whole is illustrated by a wide range of sketch maps and diagrams, many of which show great ingenuity.

Proximity to the North Polar regions has been a certain disadvantage to Canada in the past; but with the advent of aerial navigation may prove an asset, since air traffic is not restricted by ice-bound seas or lands. Great-circle routes are thus becoming of increasing importance. Prof. Taylor admits that he is somewhat of a determinist, that man can accelerate or retard the progress of a country's development, but would be unwise if he attempts to depart widely from the directions indicated by natural conditions. Thus he reaches the conclusion that, keeping to the standards of a rich new country, the population potentiality of Canada is some fifty million, or on general European standards twice that figure. These figures are reached by close reasoning which merits careful attention. The book is a valuable study and indispensable to students.

Surrey

By Eric Parker. (County Books Series.) Pp. viii+256+49 plates. (London: Robert Hale, Ltd., n.d.) 15*s*. net.

THE County Books aim at giving "a true and lively picture of each county and its people set against the background which has made it what it is". The present volume is one of the first of the series and its author is well chosen, being a field naturalist of repute and author of the well-known "Highways and By-ways of Surrey".

It is not a topographical work in the usual sense but contains much of the kind of information not found in guide-books. Without losing sight of his home county, the writer discourses pleasantly on themes which often carry him beyond it. He ranges from ancient camps to women's institutes and from the Pilgrims' Way (which he exposes as a fraud) to Brooklands. In separate chapters he discusses folk-lore, dialect, the economics of farming in 1850 and the vanished industries. He deals broadly (geologists might say summarily) with soil and structure, and generously with the scanty materials of Surrey archæology. Architecture he leaves to the photographer, and, except for museums and roads, ignores everything urban and suburban.

The greater part of the book is concerned with the author's own study of the life of the countryside. For so accessible a county Surrey has a surprising variety of wild life. Mr. Parker, from personal observation over many years, states that in 1939 it was richer in water birds than at any time in living memory, and he believes there are signs of recovery from the setback due to war-time defence measures. With much first-hand evidence he discusses the habits of nuthatches, crossbills, bullfinches, wrynecks and other rare birds, and, in controversial mood, propounds a theory of the drumming of woodpeckers. The red squirrel, he thinks, has been completely ousted by the grey, but many less familiar mammals—among them water-shrew, badger, polecat, pine marten and hare—still flourish. In similar vein he dilates upon butterflies, moths, dragonflies and the living population of woodland, garden and pond. These chapters contain much of interest for the naturalist and many suggestions to stimulate further inquiry.

The book is well printed and produced, with a good index and many fine photographs of landscape and architectural subjects. To conclude it with a featureless sketch-map dominated by roads and railways is anti-climax. W. E. S.

Introduction to Modern Physics

By F. K. Richtmyer and E. H. Kennard. (International Series in Pure and Applied Physics.) Fourth edition. Pp. xvii+759. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 36*s*.

THERE must be very few students of advanced physics who are unaware of the contents and scope of Richtmyer's important book. The appearance of the fourth edition is indeed most welcome and a matter of hearty congratulation to Dr. Kennard, who has kept the work so well up to date. The additions to the latest edition cover the more important advances of the last five years, and mainly take the form of extensive new sections on the properties of the nucleus, including details of the meson, fission and the transuranic elements, and on cosmic rays. Some basic portions of the chapter on atomic structure and optical spectra have been re-written, with much advantage.

In the concluding paragraph of the final chapter we find the interesting statement that it will be a dramatic day when mesons are for the first time generated in the laboratory. It appears from recent notes that the announcement of this dramatic discovery was somewhat accidentally delayed, and the reviewer now awaits the announcement that someone with access to a cyclotron is attempting to measure the magnetic moment of a meson by a modification of the Alvarez and Bloch resonance method which was so successful with the neutron. L. F. BATES

Practical Biology for Medical and Intermediate Students

By C. J. Wallis. Second edition. Revised, enlarged and re-set. Pp. ix+396. (London: William Heinemann (Medical Books), Ltd., 1947.) 21*s*. net.

THE second edition of this book has been extensively revised and contains much new material which will, no doubt, add to its usefulness. More than a hundred of the illustrations are new and others replace some which were present in the first edition and which were taken from other text-books. Apart from those taken from other books, the illustrations are very rough sketches which are not improved by crude shading such as one would not welcome in the work of the students for whom the book is intended. They are by no means always accurate, especially in the section on embryology, in which two transverse sections appear to have been drawn upside down, and in which Fig. 197 will do little but mislead. This is not a book which the reviewer would be happy in recommending to students. P. D. F. MURRAY

EFFECT OF PRESENT-DAY WHALING ON THE STOCK OF WHALES

By J. E. HAMILTON
Stanley, Falkland Islands

IN November 1946, the *Norsk Hvalfangst Tidende* (*Norwegian Whaling Gazette*), which is an authoritative journal, published an article on Antarctic pelagic whaling in the season 1945–46. This article contains the ominous statement[1] that although the proportion of mature females taken in the catch shows an increase on the seasons immediately preceding the War, the percentage of mature females which were pregnant shows a marked decline. In blue whales, this percentage was only 20·7 per cent and in fin whales 23·2 per cent. Percentages of pregnant females are also given for five pre-war seasons, the lowest figure appearing in 1934–35 and being 28·7 per cent for blue whales and 33·1 per cent for fin whales.

It is generally believed that the cows become pregnant in alternate years, and therefore one might expect about 50 per cent of the adult females to be in calf; or since the newly mature are, in theory at least, pregnant, the percentage might be somewhat higher. How much higher would depend on the proportion of newly mature cows to those which had already established the breeding rhythm. A drop in this percentage must be the result of three factors: (1) killing of young mature females before they have had time to be impregnated; (2) depletion of the stock of adult females in previous seasons; and (3) depletion of the total stock of adult whales so that a perceptible number of females are not fertilized.

The 1930–31 season was a record in the annals of pelagic Antarctic whaling, and 28,000 blue whales were taken. Succeeding seasons showed an increasing decline in the quality and quantity of the catch, and consequently in 1937 the minimum lengths at which whales were to be killed were fixed by international agreement. These lengths should be compared with the lengths at which whales become sexually mature; Mackintosh and Wheeler[2] published the following figures in 1929, and Mackintosh[3] produced revised lengths in 1942.

	1929	1942	
Blue whales, male	74 ft. 2 in.	74 ft. 2 in.	(no change)
,, ,, female	77 ft. 9 in.	77 ft. 1 in.	(reduced 8 in.)
Fin ,, male	63 ft. 8 in.	63 ft. 0 in.	(,, 8 in.)
,, ,, female	65 ft. 7 in.	65 ft. 3 in.	(,, 4 in.)

Matthews[4] gives the following lengths for the humpback whale:

Males	39 ft. 4 in.
Females	41 ft. 0 in.

Now the figures decided upon by international agreement as the minimum for permissible killing are:

Blue whales	70 ft.
Fin whales	55 ft.
Humpback whales	35 ft.

In every case the length is well below that at which the animal attains sexual maturity, and consequently the young cows will not have had time to reproduce.

Since the period of gestation is stated to be just over ten months for blue whales and eleven and a half months for fin whales, and the addition of the suckling period of six or seven months gives a total of about eighteen months from conception before the calf can fend for itself[2], it is obvious that the legal size limit has been fixed too low to be effective in preserving the stock. In fact, the habitual killing of immature whales of both sexes is a particularly and obviously efficient way of exterminating a species, although the effect may not be noticeable until a fair proportion of adults are dead, either naturally or by modern whaling methods.

The season 1940–41 was the last of the 'pre-war' series and the catch was comparatively small; eleven factory ships taking 12,744 blue and fin whales. A number of ships were captured or destroyed, but some of the records, at least, have survived; one factory ship went to the Antarctic whaling grounds in each of the seasons 1943–44 (837 whales) and 1944–45 (1,595 whales). However, speaking generally, there was a 'rest' from the depletion of the stock for four and a half years during 1941–45. In this period, mature females could each have produced two calves and could have become pregnant again by 1945–46, when whaling was resumed on a large scale. Now, in spite of this 'rest', the percentage of blue whales in the 1945–46 catch was only 30·7 per cent, "the lowest hitherto met in pelagic whaling in the Antarctic"[1].

The practice of the whalers is to try to catch the largest whales—the gunner who does this gains in reputation; but any whale is better than none, since the factory ships have to be filled with oil. Since the average length of the whales killed is decreasing, it must be concluded that either the larger whales are becoming more difficult to catch or that they have been pretty well killed off. The former assumption cannot stand, for against powerful modern catchers the bolting whale stands no chance. It must take frequent breaths while travelling at speed, remaining practically at the surface all the time, and so can be easily followed and run down. With regard to the latter assumption, the remarks made to me after the last Antarctic season by a very experienced whaler are pertinent. He told me that blue whales were not what they used to be, and that the enormous animals of past years were either extremely scarce or non-existent. I can remember one day in South Shetland when five or six whales were brought in, one male of 89 ft., the rest being females all 90 ft. or more. The inevitable conclusion is that the larger animals have been killed off, and that the survivors do not live long enough to attain the great size of former years. Absence or rarity of the largest examples of a wild species which is habitually hunted is a sign of a diminishing stock[5].

In making returns in the whaling industry it is customary to express the catch in 'blue whale units'. This is a deceptive practice, and does not give a true summary of the whales taken. At no time in the history of Antarctic whaling has there been a pure blue whale catch. Two principal species, the blue and fin whales, are hunted and contribute to the catch; and at one time a third species, the humpback, was also caught, but now seems to be thoroughly reduced in numbers. In the 'blue whale unit' system, the following equivalents are used:

1 blue whale = 2 fin whales = 2½ humpbacks = 6 sei whales.

These are valid equivalents; but the important point is this—the agreed figure for the last two whaling seasons of 16,000 'blue whale units' for the contracting parties may well mean that a full catch involves the killing of many more than 16,000 animals. For example, in 1945–46 the Antarctic catch was returned[6] as 8,304·8 'blue whale units', but was, in fact, made up of 13,381 whales (3,604 blue, 9,184 fin, 238 humpback and 81 sei whales, as well as 239 sperm whales and 35 "sperm and others"). This last might include some bottlenose or *Berardius*. The catch for 1946–47 has been returned[7] as 15,230·7 'blue whale units'. This represents 8,870 blue, 12,857 fin and 2 sei whales, a total of 21,729 whales[8].

There is obviously a serious danger of losing sight of the reality of the position by continued contemplation of the 'blue whale unit' value of a catch, since the number of animals killed will always be greater than the number of units allowed. An industry of this sort cannot be regulated by reference to abstractions, when it depends entirely upon a stock of wild animals, over the lives and breeding habits of which there is no control.

In the presence of vast and unestimated numbers of animals which it is desired to exploit commercially, nothing is easier than to persuade oneself that the stock is so great that it is impossible to injure it, still less to destroy it. But it is my opinion that the stocks of blue whales are showing clear signs of reduction: (1) in the rarity or absence of the huge animals of earlier seasons; (2) in the reduced proportion in the total catch of this species; and (3) in the reduced percentage of mature females which were pregnant. It is also certain that a parallel reduction of the stock of fin whales is now in progress.

The position with regard to sperm whales is somewhat different. These animals are polygamous, and there are therefore spare bulls which can very well be utilized. The sperm whales occurring outside the warm waters of the breeding grounds are almost invariably large males, which have not been able to keep their place in the herds. There is, however, no information as to the size of this stock of spare bulls, or whether they are resident in the Antarctic. Hence, the present increased killing may simply be using up the accumulation of years, either of a resident male stock, or of an annually visitant herd. The appropriate literature is not available here; but I have the clearest recollection that in the days of the old sperm whalers, certain solitary bulls were known to haunt particular areas of the sea, and continued to do so for years. Such whales, like the authentic 'Moby Dick' and 'Paita Tom', attacked boats at sight.

Finally, it may not be out of place to recall to memory the fate of the North American bison and the passenger pigeon. The former was brought to the verge of extinction and the latter completely exterminated by man for commercial purposes, in spite of the almost incredible numbers in which they both existed a little more than a century ago.

[1] *Norst Hvalfangst Tidende*, No. 11, 278 (1946).
[2] Mackintosh, N. A., and Wheeler, J. F. G., "Southern Blue and Fin Whales", Discovery Reports, **1**, 417 (1929).
[3] Mackintosh, N. A., "The Southern Stock of Whalebone Whales", Discovery Reports, **22**, 217 (1942).
[4] Matthews, L. H., "The Humpback Whale", Discovery Reports, **17**, 93 (1937).
[5] Laurie, A. H., "The Age of Female Blue Whales", Discovery Reports, **15**, 265 (1937).
[6] *Norst Hvalfangst Tidende*, No. 11, 277 (1946).
[7] *Norst Hvalfangst Tidende*, No. 3, 83 (1947).
[8] *Norst Hvalfangst Tidende*, No. 9, 322 (1947).

THE ENZYME-SUBSTRATE COMPOUNDS OF CATALASE AND PEROXIDES

By BRITTON CHANCE*

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CATALASE is a hæmatin enzyme found in relatively large concentrations in erythrocytes, liver, kidney, etc. Its extremely efficient catalysis of the destruction of hydrogen peroxide and its ability to catalyse the oxidation of alcohols by hydrogen peroxide have been recognized for some time, but very little direct evidence for the mechanisms of these reactions in terms of the theory of enzyme-substrate compounds has hitherto been obtained.

Using a micro form of the method of Hartridge and Roughton[1] and Millikan[2] for rapid spectrophotometric studies[3] of the reaction kinetics and equilibria of the unstable compounds of catalase with hydrogen peroxide and methyl or ethyl hydrogen peroxide, the catalytically active enzyme-substrate compounds of catalase with these substances have been discovered. In addition, corresponding inactive forms of the compounds of catalase with hydrogen peroxide and methyl hydrogen peroxide have been revealed. The catalase–ethyl hydrogen peroxide complex which had previously been studied by Stern[4] is shown to be one of these inactive enzyme-substrate compounds. The three active enzyme-substrate complexes share a common property of oxidizing substances such as alcohols, and in this case catalase functions as a peroxidase. But the active catalase–hydrogen peroxide complex has the unique property of acting 'catalatically', that is, of decomposing hydrogen peroxide directly into water and oxygen. These studies have shed some light on the mechanisms of these reactions.

Spectra of the Primary and Secondary Compounds

The colour of the three active or primary (I) enzyme-substrate compounds of catalase is pale green, and they have an absorption band at about 670 mμ. The Soret band is decreased in intensity and is slightly shifted towards the visible region of the spectrum, giving an isobestic point at about 435 mμ[5]. At 405 mμ the decrease of extinction coefficient per mole of hæmatin iron bound by peroxide is the same for the three primary complexes. Under suitable conditions the green compounds change into inactive or secondary (II) red compounds having two bands, at 536 and 572 mμ, approximately in the positions found by Stern[4] for catalase–ethyl hydrogen peroxide. The green-red shift of the hydrogen peroxide compounds superficially resembles that found by Theorell[6] for horseradish peroxidase and hydrogen peroxide. By analogy with his views, the green primary compounds are ferric iron peroxide complexes with ionic bonds, and the red secondary compounds are ferric iron peroxides with covalent bonds.

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Molecular Composition of Catalase – Hydrogen Peroxide

In the primary compound of erythrocyte catalase and hydrogen peroxide three out of four hæmatin-iron groups of catalase can still react with cyanide ion or alkyl hydrogen peroxide. Thus the maximum concentration of catalase – hydrogen peroxide found under any condition corresponds to only one of the total number of hæmatins present in the catalase molecule. But the alkyl hydrogen peroxides combine with all four hæmatins, as is shown by the inability of their catalase compounds to combine with cyanide. This difference in composition of the primary hydrogen peroxide and alkyl hydrogen peroxide compounds causes a four-fold difference in the decrease of the intensity of the Soret band of catalase when these compounds are formed.

While a catalase in which all four hæmatin groups are combined with alkyl hydrogen peroxide is relatively stable except in the presence of alcohols, the attachment of more than one molecule of hydrogen peroxide to catalase results in an as yet undetected complex which rapidly decomposes. It is this 'catalatic' activity which limits the saturation value of the primary catalase – hydrogen peroxide complex to one hydrogen peroxide molecule per catalase molecule. This complex is the enzyme-substrate compound concerned in the decomposition of hydrogen peroxide, but it does not exhibit the properties of a Michaelis intermediate compound because the hydrogen peroxide not only unites with catalase to form the enzyme-substrate complex but also reacts again with this complex to cause the decomposition of hydrogen peroxide. Therefore, no Michaelis saturation effect is to be expected, and the velocity of destruction of hydrogen peroxide by strong catalase solutions is directly proportional to the hydrogen peroxide concentration, at least up to 0·3 M[7]. The previous evidence for a Michaelis constant of 0·025 M appears to be an artefact due to the inactivation of catalase.

Kinetics of Formation and Decomposition and the Enzyme-substrate Affinity

Of the three primary complexes, that with hydrogen peroxide forms the most rapidly ($k_1 \sim 3 \times 10^7$ M^{-1} sec.$^{-1}$ (see ref. 5), that is, in a 1 M hydrogen peroxide solution the complex would be half-formed in about $\frac{2 \cdot 3 \log 2}{3 \times 10^7}$ sec.) and the larger the peroxide molecule, the slower the reaction ($\sim 1 \times 10^6$ and $\sim 1 \times 10^4$ M.$^{-1}$ sec.$^{-1}$ for methyl and ethyl hydrogen peroxide respectively). This decrease is much greater than could be expected solely upon the basis of diffusion velocities and must be attributed mainly to a steric effect, due possibly to restricted accessibility of catalase hæmatin to these substances. In these three reactions, the kinetics of the formation of the primary complexes clearly represent the direct combination of catalase with peroxide without the formation of any detectable intermediates. The primary complexes are not stable; they decompose spontaneously into free catalase with a velocity constant of about 0·02 sec.$^{-1}$ (the half-time for the reaction is $\frac{2 \cdot 3 \log 2}{0 \cdot 02}$ sec.) even in the complete absence of alcohols.

Catalase shows the highest affinity for hydrogen peroxide 10^{-9} M (that is, a steady-state concentration of about 10^{-9} M hydrogen peroxide is required for half-saturation of the primary catalase – hydrogen peroxide complex). This high affinity is not obtained when hydrogen peroxide 'from the bottle' is added to catalase, for then the value is $1 \cdot 6 \times 10^{-6}$ M (at a $3 \cdot 4 \times 10^{-6}$ M catalase concentration[5]) due to the partial destruction of hydrogen peroxide during formation of the primary catalase – hydrogen peroxide complex. Catalase has an affinity equivalent to about 10^{-6} M for methyl hydrogen peroxide and about 10^{-6} M for ethyl hydrogen peroxide. These values are all increased in the presence of substances such as alcohols which cause the decomposition of these complexes.

The secondary compounds of catalase and these peroxides are formed from the primary compounds comparatively slowly, are much more stable than the primary compounds, and do not appear to react directly with alcohols. They are thus inhibitors of the catalytic activity of the primary complexes.

Reactions of the Primary Complexes with Alcohols, etc.

Keilin and Hartree[9,10] have demonstrated that catalase and hydrogen peroxide or ethyl hydrogen peroxide can oxidize alcohols. These studies show that the primary catalase peroxide complexes are the active agent in these oxidations and are true Michaelis compounds since they fulfil the tests applied to the peroxidase – hydrogen peroxide complex[6]. The reaction-velocity constants for the reaction of the primary compounds with alcohols, etc. (calculated from the formulæ developed for peroxidase[6]), are very nearly independent of whether hydrogen peroxide or methyl or ethyl hydrogen peroxide is bound to catalase, and have values which decrease with the increasing size of the alcohol molecule, as is the case with the increasing size of the peroxide molecule. The velocity constant with ethanol or methanol is $k_4 \sim 1000$ M^{-1} sec.$^{-1}$ (the turnover of the primary compounds in the presence of 0·001 M ethanol is $1000 \times 0 \cdot 001$ times per sec.). The reactions of these three catalase peroxides with alcohols are not inhibited by carbon monoxide.

Direct spectroscopic measurements of the primary compound of catalase and hydrogen peroxide have been obtained in the presence of notatin, glucose, and oxygen. The absolute spectrum of the compound has been obtained with the Beckman spectrophotometer in the region 370–460 mμ and completely confirms the spectrum obtained using 'bottle' hydrogen peroxide and the rapid flow technique[5].

The direct spectroscopic studies of the turnover number of the catalase peroxides in presence of different alcohols agree with Keilin and Hartree's data obtained in coupled oxidations[10]. In such coupled oxidations the saturation of the catalase – hydrogen peroxide complex is found to be small in spite of the extremely high affinity of catalase for hydrogen peroxide. Therefore, the steady state hydrogen peroxide concentration during efficient coupled oxidations is only about 10^{-9} M. Only under these conditions is all the hydrogen peroxide utilized for alcohol oxidation and no molecular oxygen is evolved.

Two other biologically important substances have been found to react with catalase peroxides just as rapidly as do ethanol or methanol. These are formaldehyde (probably as methylene glycol) and formate. By a combination of the chromotrophic acid method[11] for formaldehyde production or disappearance and

an acidimetric method using brom-cresol purple for formic acid production and disappearance, the conversion of methanol to formaldehyde and formic acid, and the destruction of the latter, have been determined using ethyl hydrogen peroxide as the substrate. Similarly, carbon dioxide production from formate can be demonstrated in 'coupled oxidations' in which hydrogen peroxide is the substrate (Keilin and Hartree, personal communication).

The reaction of catalase–ethyl hydrogen peroxide with ethanol apparently gives acetaldehyde from ethanol and ethanol from ethyl hydrogen peroxide; the supply of ethanol is not at all depleted during the oxidation, and a small initial ethanol concentration may cause the reduction of a large amount of ethyl hydrogen peroxide. The destruction of strong ethyl hydrogen peroxide solutions by catalase studied by Stern[4], in which catalase is almost completely converted into the secondary compound, can be explained on the basis of a small percentage of the primary compound in equilibrium with the secondary compound. This primary compound reacts rapidly with ethanol present in ethyl hydrogen peroxide, and a small initial ethanol concentration will therefore cause the reduction of all the ethyl hydrogen peroxide. Thus the normal reactions of the primary compound were masked by the presence of Stern's inactive red complex.

The fact that catalase has a high affinity for ethyl hydrogen peroxide appears to contradict the results obtained by Stern[13], who failed to find appreciable inhibition of the destruction of hydrogen peroxide by catalase until about 0·1 *M* ethyl hydrogen peroxide solutions were used. However, these spectroscopic measurements show the 'stripping off' of alkyl hydrogen peroxide groups bound to catalase hæmatin upon the addition of hydrogen peroxide, with the result that only the catalase–hydrogen peroxide complex remains. In experiments in which hydrogen peroxide is continuously generated by notatin, glucose and oxygen, the rapid turnover of a large amount of catalase-bound alkyl hydrogen peroxide is observed spectroscopically. Thus hydrogen peroxide can take the place of an alcohol and can react with catalase alkyl peroxides. It does so with about the same velocity as it reacts directly with catalase. Therefore hydrogen peroxide has a reactivity of about 30,000 times $\left(\frac{3 \times 10^7}{10^3}\right)$ that of ethanol.

By a comparison of the activity of catalase-peroxides towards methanol, methylene glycol, and formic acid (all three are equally active) and ethanol, acetaldehyde, and acetic acid (the latter two are nearly inactive), it is concluded that both a hydroxyl group and a hydrogen atom attached to the one carbon atom are required of a suitable oxygen acceptor. The acceptor action of hydrogen peroxide constitutes an exception to this rule. Since the reaction velocity of both substrate and acceptor decreases with increasing size of the acceptor or substrate molecule, the acceptor molecule may have to pass through the same 'hole' as the substrate and may momentarily become attached to or near the catalase iron peroxide complex.

Secondary Compound of Catalase and Hydrogen Peroxide

When catalase is continuously supplied with hydrogen peroxide by means of notatin, glucose, and oxygen, the slow conversion of the primary to the secondary complex ensues, and the two-banded spectrum (536 and 572 μ) may be seen in the hand spectroscope. Since these bands are close to those reported by Lemberg and Foulkes[14] for a compound of catalase and ascorbic acid, and since hydrogen peroxide formed by autoxidation of ascorbic acid has already been shown to give rise to the primary complex[5], there appears to be little evidence for the existence of this catalase–ascorbic acid complex.

The secondary complex has not yet been observed spectroscopically by adding 'bottle' hydrogen peroxide to catalase owing to the decomposition of the hydrogen peroxide in a fraction of a second. Under the conditions used in the determination of Kat *F*, catalase is in contact with 'bottle' hydrogen peroxide for ten minutes or more. The observed slow decrease of activity during this time has been proved to be due mainly to the formation of the secondary complex, since after the secondary complex has been formed by notatin, glucose, and oxygen, the diluted solution has only half the Kat *F* of the untreated solution. Furthermore, at *p*H 3·5 the rate of decrease of activity[7] and the rate of formation of the secondary complex in the presence of notatin, glucose, and oxygen are both accelerated. The extent of inactivation of catalase depends upon the number of catalase hæmatins converted to the secondary complex, and this varies with the experimental conditions.

This explanation of the inactivation of catalase by hydrogen peroxide justifies the new method for the determination of catalase activity, in which strong enzyme solutions are used so that the reaction is complete in a few minutes[7]. In this procedure there is insufficient time for the formation of the secondary complex and a nearly constant activity is therefore observed.

Reaction Mechanisms

The nature of the reaction velocity constants obtained in these experiments suggests the following overall equations. The symbol "Cat" represents the four ferric-iron atoms of catalase hæmatin to which the peroxides become attached. The hydroxyl group found by Agner and Theorell[15] is considered to be replaced by the peroxide group. The equations are written in terms of methyl hydrogen peroxide and ethanol for simplicity, but similar reactions have been measured with ethyl hydrogen peroxide as substrate, and with several lower alcohols, formaldehyde, and formate in place of ethanol.

$$\mathrm{Cat(OH)_4 + 4CH_3OOH \xrightarrow[<0{\cdot}01\ sec.^{-1}]{1 \times 10^6\ M^{-1}\ sec.^{-1}} 4H_2O +}$$
$$\mathrm{Cat(-OOCH_3)_4 - I^* \longrightarrow Cat(-OOCH_3)_4 - II.} \quad (1)$$

$$\mathrm{Cat(-OOCH_3)_4 - I + 4C_2H_5OH \xrightarrow{1100\ M^{-1}\ sec.^{-1}}}$$
$$\mathrm{Cat(OH)_4 + 4CH_3OH + 4CH_3CHO.} \quad (2)$$

Thus the oxidation of alcohols by the primary catalase alkyl hydrogen peroxide complexes follows the simple theory of Michaelis and Menten, where $\mathrm{Cat(-OOCH_3)_4-I}$ is the Michaelis compound. The conversion of this primary compound into the secondary compound is negligible when the alcohol concentration is large and the peroxide concentration is small.

In Stern's experiments[4] the ethyl hydrogen peroxide concentration exceeded the ethanol concentration, and catalase was mainly in the form of the

secondary complex which he mistook for the active enzyme-substrate complex.

The oxidation of alcohols by the primary catalase hydrogen peroxide complex may also be regarded as following the Michaelis theory if proper allowance is made for the reactions of this complex with hydrogen peroxide (see equation 5) and for the fact that only one of the four catalase hæmatins is bound to hydrogen peroxide in this complex.

$$\mathrm{Cat(OH)_4} + \mathrm{H_2O_2} \xrightarrow[<0{\cdot}02\ \mathrm{sec.^{-1}}]{\sim 3 \times 10^7\ M^{-1}\ \mathrm{sec.^{-1}}} \mathrm{H_2O} + \mathrm{Cat(OH)_3(-OOH) - I^* \longrightarrow Cat(OH)_3(OOH) - II.} \quad (3)$$

$$\mathrm{Cat(OH)_3(OOH) - I} + \mathrm{C_2H_5OH} \xrightarrow{1000\ M^{-1}\ \mathrm{sec.^{-1}}} \mathrm{Cat(OH)_4} + \mathrm{CH_3CHO} + \mathrm{H_2O}. \quad (4)$$

The overall mechanism for the destruction of hydrogen peroxide by catalase is represented:

$$\mathrm{Cat(OH)_4} + \mathrm{H_2O_2} \xrightarrow[<0{\cdot}02\ \mathrm{sec.^{-1}}]{\sim 3 \times 10^7\ M^{-1}\ \mathrm{sec.^{-1}}} \mathrm{Cat(OH)_3(-OOH) - I^* \longrightarrow Cat(OH)_3(OOH) - II.} \quad (3)$$

$$\mathrm{Cat(OH)_3(OOH) - I} + \mathrm{H_2O_2} \xrightarrow{\sim 3{\cdot}5 \times 10^7\ M^{-1}\ \mathrm{sec.^{-1}}} \mathrm{Cat(OH)_4} + \mathrm{H_2O} + \mathrm{O_2}. \quad (5)$$

Although similar equations were previously proposed (for a summary see Sumner[16]), it is only now that they find experimental support. First, each step in equation 3 has been observed spectroscopically, and kinetic data have been obtained. Secondly, the reactions of $\mathrm{Cat(OH)_3(-OOH)-I}$ with alcohols according to equation 4 have been followed spectroscopically, as has the following reaction of catalase-bound alkyl hydrogen peroxide with hydrogen peroxide:

$$\mathrm{Cat(-OOCH_3)_4} + 4\mathrm{H_2O_2} \xrightarrow{3 \times 10^7\ M^{-1}\ \mathrm{sec.^{-1}}} \mathrm{Cat(OH)_4} + 4\mathrm{CH_3OH} + 4\mathrm{O_2}. \quad (6)$$

It is therefore concluded that the second step of 'catalatic' activity is a second-order reaction of $\mathrm{Cat(OH)_3(-OOH)-I}$ with a second molecule of hydrogen peroxide according to equation 5. Thirdly, equations 3 and 5 indicate that, prior to the formation of appreciable amounts of the secondary complex, the overall velocity of decomposition of hydrogen peroxide will increase linearly with initial hydrogen peroxide concentration over a wide range. This is true at least up to 0·3 *M*, since the Michaelis constant of 0·025 *M* is an artefact[7]. In addition, the rapid and slow phases of catalase activity found by George[17] probably represent catalase activity in the absence and in the presence of the secondary complex.

In efficient coupled oxidations, the steady-state concentration of hydrogen peroxide is so low that the reaction velocity according to equation 5 is negligible compared with that according to equation 4. Therefore no molecular oxygen is evolved and hydrogen peroxide is utilized quantitatively in the oxidation of alcohol to aldehyde.

The reactions 1 and 2, 3 and 4, and 1 and 6, representing the 'peroxidatic' activities of catalase, can be analysed according to the Michaelis theory; but equations 3 and 5, representing the 'catalatic' destruction of hydrogen peroxide, cannot, since consecutive reactions of hydrogen peroxide with catalase and catalase–hydrogen peroxide are involved, and the saturation value of the catalase–hydrogen peroxide complex depends upon the relative velocities of these reactions. The formation of a catalase hydrogen peroxide complex containing one hydrogen peroxide molecule per four catalase hæmatins can be explained in two ways:

A purely 'kinetic' explanation is that the ratio of the velocity constant for the hydrogen peroxide reaction of equation 5 to that of equation 3 is 3 : 1; hence the maximum concentration of the catalase–hydrogen peroxide complex is a quarter the enzyme concentration. In this mechanism for equation 5, the hydrogen peroxide molecule may collide directly with the peroxide group attached to hæmatin or may collide with one of the three free catalase hæmatins to give, in either case, oxygen, water and free catalase. In the latter case, a catalase with only one hæmatin group would be 'catalatically' inactive (for a more detailed discussion see Theorell[18]). A second explanation assumes 'special properties' of the catalase–hydrogen peroxide complex. The existence of this complex is necessary for the decomposition of hydrogen peroxide into free oxygen and water or into radicals at the free catalase hæmatins, but the complex itself is not decomposed by these reactions. The complex may, however, decompose spontaneously or on reaction with alcohols, etc. In this case also a one-hæmatin catalase would be 'catalatically' inactive. These two mechanisms give very nearly identical mathematical solutions over the ranges of experimental conditions that can now be investigated with accuracy, and therefore a final conclusion on the exact mechanism for 'catalatic' activity is not yet possible.

A comparison of equations 2, 4 and 6 with equation 5 indicates that there is no fundamental difference between the 'peroxidatic' and 'catalatic' reactions; 'catalatic' activity appears to be the special case of peroxidatic activity when the substrate and acceptor are identical.

Complete papers on these experiments will be published elsewhere.

I wish to acknowledge my gratitude to those who have taken an active interest in the progress of this research and who have made many useful criticisms and suggestions: Profs. H. Theorell, L. Pauling, D. Keilin and F. J. W. Roughton, and Dr. E. F. Hartree. I am indebted to Dr. R. K. Bonnichsen for supplying the bulk of the catalase preparations used in these experiments.

* The kinetics of this reaction do not follow first or second order kinetics with accuracy.

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THE TELECOMMUNICATIONS RESEARCH ESTABLISHMENT, MALVERN

AN exhibition of the work carried out at the Telecommunications Research Establishment of the Ministry of Supply was held at Great Malvern during May 25–27. This was the first occasion on which this well-known establishment has been open to the public. The Telecommunications Research Establishment, or T.R.E. as it is generally called, became famous during the war years on account of the pioneering research on radar carried out there. It developed from the small research group at Bawdsey originally under Sir Robert Watson-Watt to become one of the largest Government research establishments and attracted many of the leading scientific workers in Britain.

During the War, T.R.E. was responsible for research and development of most of the radar equipment for the Royal Air Force. The story of this work is now very well known. At the close of hostilities many of the leading scientific workers at T.R.E., as was indeed expected, returned to academic life. A considerable number of war-time recruits, however, stayed on in the Government Scientific Service and have carried on the tradition of T.R.E. After the War the activities of the Establishment were broadened in scope and a considerable part of the effort on military problems was turned to civil problems and to fundamental research.

The Establishment is now divided into three Departments—Physics, Radar and Engineering. The Physics Department is mainly concerned with fundamental research on the properties of extremely short radio waves, on infra-red radiation and on various fundamental problems in electronics. It includes a theoretical physics group. Some research on supersonics is also being carried out and the application of radar techniques to various problems in meteorology is being studied. A considerable part of the work of the Physics Department is supported and financed by the Department of Scientific and Industrial Research. The Radar Department is responsible for research and development of radar equipments for the Royal Air Force, the Naval Air Arm and the Ministry of Civil Aviation. Examples of projects on which research is taking place are the location by radar of bombing targets, the location and attack of enemy aircraft, radio navigational aids and the use of radar for the control of air traffic. The Engineering Department is responsible for the design and construction of apparatus to the requirements of the scientific staff and for investigating new materials, finishes and component techniques to meet the wide variations of temperature and humidity encountered at high altitudes and in various parts of the world. It includes the Engineering Unit, which is one of the largest and best equipped workshops in Britain.

The Ministry of Supply School of Electronics is situated within T.R.E. Technical instruction is provided in the School for craft and engineering apprentices. Radar courses are arranged for all classes of new entrants, and advanced refresher courses for internal staff. A department of the Atomic Energy Research Establishment is also at present situated at T.R.E. It is concerned with the development of high-energy particle accelerators for nuclear physics and medical research work, and with electronic instrumentation for measuring all forms of radiation in the field of nuclear physics.

The exhibition was opened on May 25 by the Right Hon. G. R. Strauss, Minister of Supply. On that day leading representatives of the Fighting Services, the Civil Service, universities and industry, together with representatives of the Press, were shown a selection of the work of the Establishment. On May 26, about 1,400, representing other Government establishments, industry, and the universities and technical colleges, attended the exhibition. On May 27, senior science scholars from local schools and members of the public from Malvern and nearby towns attended the exhibition. This was made an occasion for the formal opening of the Ministry of Supply School of Electronics by Mr. J. Freeman, M.P., Parliamentary Secretary to the Ministry of Supply.

It was clearly possible to show only a selection of the work of T.R.E. This selection was representative of that carried out in all departments, and items were chosen which were free from any security restrictions. A few of the more interesting exhibits are described below.

Application of Radar to Meteorology

A number of exhibits illustrated the application of radar techniques to meteorology. Photographs of rain clouds and of the radar echoes obtained from them were shown. A light-weight microwave radar equipment, for installation in large civil aircraft, was demonstrated. This equipment is to enable aircraft to avoid dangerous clouds, particularly those of the cumulo-nimbus type. Fortunately this type of cloud gives an excellent radar echo at a wave-length of 3 cm. at which the equipment operates. An interesting problem in the study of rain is the determination of the size of raindrops, particularly immediately below precipitating clouds. A method of making this kind of measurement by use of a specially designed microphone in an aircraft was exhibited. An interesting application of pulsed light to the measurement of the height of the cloud base was also shown. Another application of radar techniques is the radar sonde. Radar is used to locate the position of the sonde carried on a balloon. Thus observations of wind speed can be made from a single station. Meteorological information as determined by the instruments carried in the sonde is transmitted to the ground by the train of radar pulses.

New Developments in Microwave Technique

A number of exhibits illustrated the development of microwave technique for wave-lengths near 3–10 cm. These included demonstrations showing the improvement of receiver performance and the development of very high power transmitters, both aimed at increasing the range of detection by radar equipment. The development of techniques to enable even shorter wave-lengths to be used was illustrated. One exhibit, for example, showed the method of construction of valves for wave-lengths of the order of 8 millimetres and of the associated microwave components.

D.C. Amplifier using Magnetic Modulator

The amplification of small direct currents is much more difficult than that of small alternating currents,

and the technique generally adopted is to turn the direct current into alternating current before amplification. A new type of amplifier which uses a magnetic modulator to effect this conversion was exhibited. The apparatus is particularly suitable for amplification of small signals from low-impedance sources such as thermocouples.

Electronic Digital Computing Techniques

An electronic 'memory' for a computing system was demonstrated. This is based on the storage of an electrostatic charge distribution produced on the fluorescent screen of a cathode ray tube by a bombarding beam of electrons. Many binary numbers of 32 digits can be simultaneously remembered by this system, which has been developed in association with Prof. F. C. Williams of the University of Manchester. A binary number arithmetical unit was also shown which will add together two 32 digit binary numbers in a time of the order of 350 microseconds.

Infra-red Research

A number of exhibits illustrating the use of infra-red radiation for the detection of temperature differences were shown. For radiations in the range of 1–3 microns the very rapid response of the lead sulphide type of cell makes it useful for the detection of temperature changes which are very short-lived. One exhibit illustrated its use for the detection of hot spots caused by friction. These may last only a small fraction of a millisecond but are clearly shown by the lead sulphide detector. The use of an electronic A.C. amplifier operating at a frequency of 5 cycles per second in conjunction with a thermocouple of special design was shown as an example of an extremely sensitive detector of radiation arising from bodies having only a small difference in temperature from their surroundings. The amplifier is thought to be the best of its type designed so far and is capable of showing the Johnson noise from a 1-ohm resistance in a band-width of 1 cycle per second.

Automatic Recording Spectrophotometer

An automatic recording spectrophotometer which has been designed for the Medical Research Council was exhibited. This instrument enables an ultra-violet absorption spectrum of a substance in liquid solution to be obtained as a trace on photographic paper. The wave-length scale and absorption are simultaneously recorded on the photographic paper so that on development complete information is obtained without further calibration. This enables specimens to be examined with extreme ease and rapidity. The instrument provides an excellent example of the use of electronic servo mechanisms.

Automatic Following Telescope

A working model of an astronomical telescope locked by electronic means to a star at which it is pointed was shown. The telescope contains a device capable of determining the position of a star in its field of view, and any deviation of the star from the centre of the optical system produces correcting signals which drive the telescope to keep the star centrally aligned.

Air Traffic Control

By means of radar equipments sited at Malvern and near London airport a display showing the position of air traffic in the southern half of England was shown. The exhibit illustrated the control of aircraft arriving at a busy airport using radar information.

Airborne Radar

A number of exhibits showed the latest improvements in a number of radar navigational aids developed during the War. Another exhibit showed the radar equipment used in a modern bomber. This included the *H2S* equipment for obtaining a radar map of the ground over which the aircraft is flying, and the automatic gun-laying equipment used in the rear turret. The latter equipment enables a rear gunner to open fire at an approaching fighter which he cannot see visually. Some recent developments in the radar equipment for night fighters were also shown. The equipment enables the fighter to locate and follow an enemy bomber in the dark and to manœuvre into such a position that the pilot can see the enemy aircraft and attack it. A device was also shown which enables the radar information to be projected on to the pilot's windscreen so that he can at the same time view it and look out for the enemy aircraft.

Suppressed Aerials

As aircraft speeds increase, the drag of external aerials becomes more and more intolerable, and as sonic speeds are approached it is impossible to have external aerials at all. Methods of suppressing aerials by use of plastic fittings to the aircraft and by the use of slot aerials were illustrated. These methods represent considerable advances in aircraft aerial technique.

Ultrasonic Research

A number of applications of ultrasonics were illustrated, such as the measurement of ultrasonic absorption in metals as a means of determining the grain size, and the detection of obstacles and flaws by means of ultrasonic technique. The methods used were based on radar principles and employed pulses of ultrasonic energy.

Electronics for Atomic Energy

The exhibitions of the Atomic Energy Electronics Group included an electron accelerator operating on the synchrotron principle and producing electrons having an energy of 15 million electron volts. Various instruments were also demonstrated which are used for the measurement of radiations met with in nuclear physics research. In particular, a number of instruments called 'health monitors' were shown which are used to ensure that workers are not being exposed to an amount of radiation sufficient to cause appreciable bodily harm.

The Ministry of Supply School of Electronics gave a display of equipment illustrating the historical development of microwave technique. An exhibition arranged by the Engineering Department illustrated the development of new types of radio components designed to withstand extreme climatic conditions and also showed some of the latest types of miniature radio components which have been developed with the view of reducing the size and weight of airborne radio equipment. In addition, a number of films, including "RDF to Radar", were shown.

OBITUARIES

Mr. J. J. Shaw, C.B.E.

THE death on May 23 of Mr. John Johnson Shaw at the age of seventy-four severs yet another link with the pioneers of the study of earthquakes in Great Britain.

J. J. Shaw was born at Gornal, near Dudley, educated at King Edward's School, Birmingham, and then apprenticed to an engineer. During the latter part of his engineering studies, he designed some gas and some steam pumps, and although he soon forsook his engineering to become a pawnbroker, he never lost his love for engineering. It was in the year 1908 that he read a newspaper article on the recording of earthquakes, and this encouraged him to visit Dr. John Milne, who, having retired from his professorship at Tokyo Imperial University, had settled in the Isle of Wight and set up a seismological observatory there. John Milne and J. J. Shaw became friends, and Shaw, on returning home, set up his first seismograph, which included as components an old treacle tin as drum, a wheat straw as pointer and a driving mechanism taken from an old German clock costing 1*s.* 11*d.* This instrument recorded some violent, world-shaking earthquakes, including the Messina earthquake of December 28, 1908, and with this early success and John Milne's encouragement, Shaw set about improving his instrument. The task became a life study, and in each Milne-Shaw seismograph made under Shaw's personal supervision some improvement on the previous one was embodied. Milne–Shaw seismographs are now working in many observatories throughout the world and are excellent for recording strong distant earthquakes.

Microseisms are now thought to be largely due to storms at sea. They gave ever-recurring trouble to the early observers, and Shaw suggested that data concerning them could best be obtained by the use of the tripartite seismograph station (British Association Seismological Committee Report, 1920), a method which in the hands of Father J. E. Ramírez at St. Louis, U.S.A., and later workers has given such good results.

Shaw, like John Milne, never lost an opportunity to make a friend for seismology. He fitted an electric bell to the seismograph system at his home in West Bromwich, so that he could be ready with instrumental results when any newspaper reporter rang him up about an earthquake. Reporters were often surprised at his perpetual cheerfulness over the telephone at any time of the day or night, and at the fact that his seismograph and his reference files often gave earlier information than their own telephone systems. A few years before the Second World War, Shaw was particularly pleased to set up one of his instruments in Selfridges Store in London, so that any passer-by could see an earthquake being recorded should one occur at the instant he happened to be near the instrument. This instrument was suspended from one of the main structural steel pillars of the building, and since the steel went deep into the ground the pendulum recorded waves from distant earthquakes but was unaffected by street traffic or the movement of people in the store. This instrument is now in the Science Museum at South Kensington.

Shaw first became a member of the British Association Seismological Committee in 1914, probably having been proposed by his friend John Milne just prior to the latter's death in July 1913. John Milne had been honorary secretary of the Committee for many years, and Prof. J. Perry had taken over the duties of secretary as a temporary measure on John Milne's death. At Manchester on September 8, 1915, Prof. Perry resigned the secretaryship and J. J. Shaw took over. He continued as honorary secretary until July 26, 1946, and was a member of the Committee until his death. As a member of the Seismological Committee of the British Section of the International Union of Geodesy and Geophysics, J. J. Shaw took part in many international meetings and established a world-wide reputation as an instrumental seismologist. He was also a popular scientific lecturer of considerable renown in the Birmingham district, having an infectious enthusiasm for popular science in general and instrumental seismology in particular; being a kindly, forthright man, he made many friends. He was made C.B.E. in 1931, and awarded an honorary M.Sc. by the University of Birmingham a year later.

Mr. Shaw had suffered from knee trouble for some years, and on May 22 one leg was amputated; the operation was successful, but he had a relapse and died the next day. He will be missed by many people not only in his home town and district, but also by a wide circle of friends and acquaintances throughout the world. His son, Mr. Harold V. Shaw, is expected to continue the observatory.

ERNEST TILLOTSON

Dr. J. M. Dalziel

DR. J. M. DALZIEL, whose death was recently reported, was educated in Edinburgh and spent the first years of his career in South China as a medical missionary with the English Presbyterian Mission. His interest in natural history was evident even then. He eventually transferred to the West African Medical Service, where his work during many years took him to all the British West African Colonies. His greatest love was for Northern Nigeria in general, and the Hausas in particular. He was a good Hausa scholar, and also had a considerable knowledge of Fulani. He was a keen observer, and collected a number of new species, especially of Northern Nigerian plants, although he collected animals as well, and recorded their vernacular names. He tried to record the vernacular names and the uses of every plant he encountered, and his field notes were always most thorough and painstaking. His Hausa names of plants, with scientific equivalents, and often with derivations of the names, were published in 1916 as "A Hausa Botanical Vocabulary", an invaluable work, unfortunately now out of print, and in which the majority of the information given is still accurate. During that period Dalziel helped, with his field notes, in J. H. Holland's monumental "Useful Plants of Nigeria".

In zoology Dalziel was a keen bird watcher, as his little booklet "Bird Life round Accra" testifies. He also collected insects of importance as vectors in tropical medicine, and presented his carefully prepared specimens to the University of Edinburgh.

On his retirement from the West African Medical Service, Sir Arthur Hill, then director of the Royal Botanic Gardens at Kew, secured his services to help Dr. J. Hutchinson in the production of the "Flora of West Tropical Africa", a work which occupied the years 1923–36. It was a fortunate choice, for Hutchinson had a great knowledge of the African

material in the Kew Herbarium, and Dalziel had a wide field knowledge in West Africa.

But it was the appendix to this flora, entitled "The Useful Plants of West Tropical Africa" (1937), which came to be Dalziel's *magnum opus*. The amount of information and local names he collected was amazing; there were 10,000 vernacular names from Nigeria alone. His information covered all the West African Colonies, including much information from the French West African Colonies. His thorough recording of the medicinal uses, for example, could only be done effectively at that stage by one who, like Dalziel, combined a thorough knowledge of both the plant life and the tropical diseases of the area, together with the necessary persistence and thoroughness in recording his own observations and those supplied to him by others. His correspondence during these many years of compilation must have been immense, and his critical faculty in dealing with it adequately must have been exceptional.

His work is a sound basis for all future work on the uses of West African plants, and he quotes all the authorities he used. This work was his main scientific work, done with endless care, at financial loss to himself, and with inadequate recognition in his life-time. Dalziel has put into the hands of educated Africans, as well as into those of European research workers, the requisite means for further research in the subject, which is of vital importance for the future welfare of West Africans themselves. In his work of recording the medicinal uses in particular, he has laid a foundation on which those of us who follow him can build with confidence.

F. R. Irvine

Mr. G. L. Overton

Mr. George Leonard Overton, who had been keeper of the Department of Air and Water Transport at the Science Museum during 1926–35, died at his home in London on May 15. Born at Coventry on May 18, 1875, he was educated at Bradford Technical College and passed to the Royal College of Science, London, where in 1897 he graduated in physics and for a year held the post of assistant in the Astronomical Department.

In 1898 Overton was appointed to the then South Kensington Museum by competitive examination—in which he figured with high distinction—and was concerned with the presentation of various scientific subjects, notably time measurement, which for him was a hobby as well as a serious study. He was a fellow of the British Horological Institute and of the Physical Society, and in 1922 published a book on clocks and watches.

Overton had the analytical type of mind that is appropriate to museum work. He was a purist; not only in choice of words, but also in all matters pertaining to the restoration and preservation of exhibits. His regard for accuracy was so great that it tended to limit his output; but the official publications of which he was the author evinced a standard of precision rare even in technical literature.

A serious operation during the latter years of his service handicapped him, but it made his admirable custodianship of the collections for which he was responsible even more praiseworthy. He was one of the very few officers surviving who constituted the higher technical staff of the Science Museum on its separation from the Victoria and Albert Museum in 1909 and inception as a separate entity. The tradition so ably established by Overton and his contemporaries is the foundation upon which that national museum of science and industry is to-day erected. All who knew him, admired his knowledge, and experienced the kindness and generosity of his personal relationship, will deeply regret his passing.

M. J. B. Davy

NEWS and VIEWS

Royal Society of London: New Foreign Members

On May 27, Prof. D. W. Bronk, Prof. L. E. J. Brouwer, Prof. M. J. G. C. Caullery and Prof. L. C. Pauling were elected foreign members of the Royal Society of London.

Prof. D. W. Bronk is known not only for his own researches in biophysics but also as the director of the Eldridge Reeves Foundation for Medical Physics since its foundation in 1929. This Foundation forms a part of the University of Pennsylvania, and has acquired an international reputation under his direction and become a flourishing centre of research under his genial and skilled guidance and produced many distinguished pupils. In his own work, his early physical training shows in the precision and definition which he has brought to many biological problems. His particular contributions have been on electrical phenomena in nerve, following his work with Adrian in 1929 on the mode of discharge of impulses by motor nerve cells; he elucidated the functions of the carotid sinus and brought light to many problems of sensory physiology and of synaptic transmission. His work during the War was concerned with many applications of science to the Services, especially those relating to night vision. He was indefatigable in travelling to theatres of war and across the Atlantic as a co-ordinator of research between the laboratory and the field.

L. E. J. Brouwer, professor of mathematics in the University of Amsterdam, may be regarded, along with Cantor and Poincaré, as one of the founders of modern topology if only on account of his proof in 1911 that dimensionality is a topological invariant. Brouwer's life work has, however, been concerned with a theory of the nature of mathematics, which he put forward in its first state in 1907. This theory, known as intuitionism, denies in particular the universality of the law of the excluded middle, and has aroused much controversy.

Prof. Maurice Caullery is the most distinguished of French zoologists. During his long and active career, his students have included many of the present holders of zoological chairs in France and many other well-known biologists, including some in Great Britain. Until 1939, he held the chair of biology at the Sorbonne. He is a member of the Institut de France, member of the Belgian Royal Academy, foreign member of the American Academy of Arts and Sciences, LL.D. of St. Andrews, and has been exchange professor of Harvard University. He was president of the Société de Zoologie and of the Société de Biologie of France. He is president of

the Permanent Committee of the International Zoological Congress, and honorary fellow of the Zoological Society and foreign member of the Linnean Society, which awarded him its Gold Medal in 1947. Caullery's 'Jubilé Scientifique' on his seventieth birthday in 1939 was the occasion of remarkable tributes to him and his work paid by many distinguished men of science. His contributions to zoology and general biology are remarkable for their positive and fundamental nature, their wide range and their stimulating character. He has made great contributions to parasitology in a variety of distinct groups of animals. It was he who discovered the Haplosporidia, a new order of Sporozoa. He worked out the life-cycles and relationships of parasites in many groups, particularly Crustacea, Turbellaria and Orthonectidæ. His studies have thrown much light on the biological relations of a parasite to its host.

Prof. L. C. Pauling, professor of chemistry in the California Institute of Technology, is distinguished for his researches on valency and on structural organic and inorganic chemistry. Through his profound knowledge of physics and mathematics he has been able to apply quantum mechanics to problems of chemical valency bonds. His comprehensive work is embodied in his book, "The Nature of the Chemical Bond" (1939), which is now recognized as a classic in chemistry. For this, and other cognate researches, Prof. Pauling was awarded the Davy Medal of the Royal Society in 1947.

Pontifical Academy of Science: New Members

THE following have been appointed members of the Pontifical Academy of Science: Prof. J. M. Albareda-Herrera, professor of geology and director of the Institute of Edaphology, Ecology and Plant Physiology, University of Madrid; Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, London; Prof. E. Cruz-Coke, professor of physiological and pathological chemistry, University of Santiago; Prof. A. De Castro, professor of clinical medicine, University of Madrid; Prof. Edward A. Doisy, professor of biochemistry, St. Louis University School of Medicine; Prof. Herbert S. Langfeld, Stuart professor of psychology and chairman of the Department of Psychology, Princeton University.

Physiology at St. Andrews: Prof. P. T. Herring

THE retirement of Prof. P. T. Herring from the Chandos chair of physiology in the University of St. Andrews brings to a close a long term of office, for he has occupied the chair for forty years. Prof. Herring was educated in New Zealand and later at the University of Edinburgh, where he came under the influence of Sir Edward Sharpey-Schafer, with whom he later collaborated. His first researches, published in 1908, concerning the development and structure of the pituitary gland, quickly gained recognition and gave the histological background for many of the earlier investigations on the function of this body. The colloid bodies he described are still referred to as 'Herring's bodies', and illustrations of his original preparations demonstrating the vascular bed of the pituitary are to be found in current textbooks. Later, the structure and function of the thyroid claimed his interest, and again he was responsible for contributing much valuable knowledge. Prof. Herring went to St. Andrews in 1908 with a reputation as a lecturer of great distinction, and during his tenure of the Chandos chair he has systematically developed the Department of Physiology and the teaching courses in accordance with current physiological thought. He himself has invariably undertaken the greater part of the teaching in his Department, and there will be many at this time who will recall his clear and stimulating lectures. In addition to his other duties, Prof. Herring has taken a large and vital part in the administration of the University of St. Andrews. He acted as dean of the Faculty of Science during 1921–39 and served as an assessor of the Senatus on the University Court for four periods. His colleagues and the many students who have gained so much from his kindly interest and help will wish him long years of quiet and happiness in his retirement.

Dr. A. E. Ritchie

DR. A. E. RITCHIE, who has been appointed to the chair of physiology in the University of St. Andrews in succession to Prof. P. T. Herring, has had a wide training, having graduated M.A. and B.Sc. in mathematics, zoology and physiology at the University of Aberdeen, and later, in 1940, obtained the M.B., Ch.B. in the University of Edinburgh. In 1945 he was awarded the Gold Medal for his M.D. thesis on the electrical diagnosis of nerve injury. His postgraduate work began when he was holding a Carnegie Scholarship in the Physiology Department of the University of Edinburgh. In that Department he has stayed, combining varied teaching experience with original research. His most important contribution, both to physiology and medicine, has been to design a reliable and relatively simple and compact electronic apparatus for the determination of strength-duration curves, thus converting a laboratory procedure into a practical clinical one. This apparatus is valuable in the diagnosis of nerve injury. Thus Dr. Ritchie's interests lie in the fields both of physiology and of clinical medicine. He has published a number of papers on muscle and nerve reactions both in health and disease, and has contributed an article on muscle reactions in the forthcoming "Encyclopædia of British Surgical Practice".

Proposed Central Publication of Scientific Papers

MRS. LUCIA MOHOLY, of 127 Sloane Street, London, S.W.1, writes: "In describing American methods of auxiliary publication in *Nature* of June 5 (p. 896), Mr. Watson Davis speaks with authority on the practical value of certain organised measures adopted in the United States to a larger extent than in some other countries. If corresponding methods have not yet attained comparable popularity in Great Britain, it does not follow that the question of systematically using and organising photographic reproduction to assist science and learning has not been taken care of. Not only have suggestions for extensive uses been put forward on many occasions, but also a specific study has been made of the part photographic reproduction can play in relation to Prof. J. D. Bernal's project. With the Royal Society's Scientific Information Conference in sight, a formal statement setting out the merits of these methods for alternative and supplementary services was drafted and, upon Prof. Bernal's request, submitted to the appropriate quarter. This followed an outline of these methods and their potential uses for the publication and distribution of scientific papers, at a meeting on Apri 21, at the Society for Visiting Scientists. An earlier approach, also with specific reference to Prof. Bernal's project, was made at the Conference on the Publica-

tion and Classification of Scientific Knowledge, held at Trinity College, Cambridge, on October 25, 1947.

"The use of documentary reproduction for auxiliary publication, and its eminent suitability as an aid to science and learning in general, were the subject of two articles in *Nature* (157, 29, 38; 1946), where a new type of service was forecast to 'keep men of science currently informed of all the literature published on their respective subjects'. It was there, also, that the setting up of central agencies was suggested and interchange of services and close co-operation with bibliographical centres and scientific institutions was advocated. A memorandum to this effect was also submitted to Unesco (through the offices of its predecessor, the Conference of Allied Ministers of Education, 1945). In a paper read to the Royal Society Empire Scientific Conference, 1946 (Report, vol. 1, pp. 717–721), and another put before the Co-operation Committee of the Library Association in the same year, the setting up of a Central Office of Documentary Reproduction was recommended to act as a co-ordinating centre for Great Britain and the British Commonwealth and Empire; while a renewed appeal for the co-ordination of policy in Documentary Reproduction on a world scale was made to the Sixteenth Conference of the International Federation of Documentation in Paris, November 1946 (F.I.D. Communicationes, 13, Fasc. 4, 60; 1946). For the furtherance of these ideas, Mr. Watson Davis' letter has provided valuable evidence which should bring closer to realization some of the services for which the plans have been prepared in former years."

British Commonwealth of Nations Scientific Liaison Offices

THE British Commonwealth of Nations Scientific Liaison Offices (London) have been opened on the third floor of Africa House, Kingsway, W.C.2. This is one of the measures to facilitate co-operation in the civil aspects of science within the Commonwealth decided on by the British Commonwealth Scientific Official Conference held in London in 1946. For a number of years several of the Commonwealth countries have maintained scientific liaison offices in London, and these, together with the ones now being established, will have their headquarters in Africa House. Each of these offices will continue to operate as in the past, retaining complete independence of action; but the convenience of occupying adjacent premises will facilitate co-operation between them on matters of common interest. For ease of reference to the group of independent offices as a whole, the title given above has been chosen, with the abbreviation B.C.S.O. (London) for common use. The offices taking part in the scheme are those of Australia, Canada, Central African Council, India, New Zealand, South Africa and the United Kingdom. Pakistan and the Commonwealth Agricultural Bureaux will be represented, and the Overseas Liaison Division of the U.K. Department of Scientific and Industrial Research will work in Africa House. In Washington the scientific liaison offices of the Commonwealth countries are associated under a similar scheme.

British Seismological Observatories

THE Stonyhurst College Observatory has now ceased to record earthquakes, as has also the Royal Observatory at Edinburgh. Mr. E. W. Pollard has moved from the Isle of Wight to Dorking, Surrey, and hopes to set up his seismograph at his new home. He has presented a seismograph with mass 40 lb. to the County Secondary Grammar School at Newport, Isle of Wight, where the instrument has been set up and is being standardized. It is hoped to install good time-keeping apparatus shortly.

International Seismological Summary

SINCE the British Association meeting in September 1947, the United Nations Educational, Scientific and Cultural Organisation has given a substantial grant-in-aid to the International Union of Geodesy and Geophysics for the International Seismological Summary (see *Nature*, April 17, p. 616). The staff of the I.S.S., consisting of Mr. J. S. Hughes and two assistants, have been at work at Kew for more than a year now, and the full issue for the year 1936 has been produced and partly distributed. In addition, much work has been done on the Summary for 1937, portions of this being in the hands of the printers. We are informed by Dr. Wang Ging-Hsi, of the Natural Sciences Section of Unesco, that the Organisation will assist similarly with another grant in the present year.

Natural History Journals

ONE by one some of the journals whose light flickered and went out in 1939 are being revived. The latest is the *Scottish Naturalist* which now enters on its fifth stage under the joint editorship of Prof. V. C. Wynne-Edwards and Dr. J. W. Campbell. The first volume of the new series is mainly devoted to birds of Scotland. That country has also produced a new journal, *Scottish Zoo and Wild Life*; this has been inaugurated by the Zoological Society of Scotland for the benefit of its fellows and all who are interested in animal life. Cordial wishes for their success are extended to both these journals while naturalists everywhere will also wish to congratulate the *North-Western Naturalist* on reaching its twenty-first anniversary under the able editorship of Mr. A. A. Dalliman.

National Advisory Council for Education in Industry and Commerce

THE following have been elected to serve on the Standing Committee of the National Advisory Council for Education in Industry and Commerce: Lieut.-General Sir Ronald Weeks (chairman), Sir Samuel Gurney-Dixon (vice-chairman), Sir Graham Savage, Mr. E. L. Russell, Mr. A. Ballard, Dr. Percy Dunsheath, Prof. F. H. Garner, Prof. R. G. Batson, Sir Robert Wood, Dr. T. J. Drakeley, Dr. H. Schofield, Mr. J. Wilson, Dr. J. E. Myers, Sir Charles Tennyson, Sir Arthur Smout, Mr. G. S. Heaven, Sir Arthur Fleming, Mr. B. J. Ewing, Mr. G. H. Lowthian, Mr. W. T. Mainwaring, Mr. M. F. Titterington, M.P., Mr. E. G. Gooch, M.P., Dr. F. C. Toy, the Hon. Josiah Wedgwood, Captain A. M. Holbein. Sir Samuel Gurney-Dixon was also elected vice-chairman of the Council.

Institution of Mining and Metallurgy: Awards

THE Gold Medal of the Institution of Mining and Metallurgy, the highest distinction which the Council of the Institution has power to grant, has been awarded to Mr. G. Carleton Jones, resident director in South Africa of New Consolidated Gold Fields, Ltd., in recognition of his distinguished services to the gold mining industry of South Africa, and in particular to the development of the West Rand. Honorary membership of the Institution has been

conferred on Dr. William Cullen, Dr. T. A. Rickard and Prof. S. J. Truscott, in recognition of their long and valued services to the mining and metallurgical profession and to the Institution. The "Consolidated Gold Fields of South Africa, Ltd." Gold Medal has been awarded jointly to Dr. Anthony Caplan and Mr. J. K. Lindsay, for their work on the effect of high temperatures on working efficiency in deep mines.

Institution of Civil Engineers: Officers

THE following have been elected officers of the Institution of Civil Engineers for the Session 1948–49: *President*, Sir Jonathan Davidson; *Vice-Presidents*, Sir Reginald Stradling, V. A. M. Robertson, Dr. W. H. Glanville, A. S. Quartermaine; *Other Members of Council*, H. E. Aldington, Sir Stanley Angwin, Sir Donald Coleman Bailey, Prof. J. F. Baker, G. Baxter, W. S. Cameron, J. Chambers (India), H. F. Cronin, E. L. Everatt (Pakistan), A. Gray (Canada), A. C. Hartley, Prof. Douglas Hay, G. H. Humphreys, Sir Claude Inglis, L. Leighton, L. A. Mackenzie (South Africa), G. M. McNaughton, H. J. B. Manzoni, W. L. Newnham (New Zealand), Prof. A. J. S. Pippard, J. Rawlinson, W. P. Shepherd-Barron, T. H. Silk (Australia), J. C. L. Train, D. M. Watson, Sir Arthur Whitaker.

University of London: Appointments

THE following appointments in the University of London have been announced: Prof. J. W. S. Blacklock, professor of pathology in the University of Glasgow, to the University chair of pathology tenable at St. Bartholomew's Hospital Medical College as from October 1; Mr. James Whillis, reader in anatomy in Guy's Hospital Medical School, to the chair of anatomy tenable at the School as from October 1; Dr. Hugh Ford, technical director, Paterson Engineering Group, to the University readership in applied mechanics tenable at the Imperial College of Science and Technology as from May 1.

The following titles have been conferred in respect of posts at the Colleges mentioned: professor of social studies in the University on Mrs. Barbara Wootton (Bedford College); reader in biochemistry in the University on Dr. H. W. Buston (Imperial College of Science and Technology); reader in biochemistry in the University on Mr. Wilfrid Lawson (Middlesex Hospital Medical School); reader in morbid anatomy in the University on Dr. D. M. Pryce (St. Mary's Hospital Medical School).

The degree of doctor of science has been conferred on Mr. B. H. Crawford, of University College.

Thirteenth International Congress of Zoology

THE Chief Cashier, Exchange Control, Bank of England, states that a special allotment of the equivalent of £36 in foreign exchange will be provided to approved persons to enable them to attend the International Congress of Zoology in Paris during July 21–27. Anyone wishing to obtain this special allotment should submit an application on Form *T*.2, quoting the reference *I*/392 *EC* 902, through the medium of their own bankers, from whom the necessary forms may be obtained. The Bank of England authorities state that they would only be prepared to consider names sponsored by the Zoology Section, International Union of Biological Sciences, and therefore any applicants are advised also to notify the president of the Section, Dr. Edward Hindle, Zoological Society, Regent's Park, N.W.8.

Announcements

THE Lord President of the Council has appointed the following to be members of the Chemistry Research Board of the Department of Scientific and Industrial Research for a period of four years: Mr. A. L. Bacharach, head of Nutrition Unit, Glaxo Laboratories, Ltd.; Prof. H. J. Emeléus, professor of inorganic chemistry, University of Cambridge; Prof. D. M. Newitt, professor of chemical engineering, Imperial College of Science and Technology, London.

THE following have been appointed to the Advisory Council on Scientific Research and Technical Development, Ministry of Supply, which advises on the important scientific and technical problems with which the Ministry is concerned: Sir Howard Florey, professor of pathology, University of Oxford; Prof. J. L. M. Morrison, professor of mechanical engineering, University of Bristol; Prof. L. Rosenhead, professor of applied mathematics, University of Liverpool.

THE Royal Astronomical Society wishes to direct the attention of authors to the fact that arrears of papers accepted for the *Geophysical Supplement* of the *Monthly Notices of the Royal Astronomical Society* have now been published. It is anticipated that in future the average delay between the acceptance and publication of geophysical papers will only be a few months. The arrears of papers accepted for the *Monthly Notices* are now all in print and will be published and distributed in the near future; after which the average delay between acceptance and publication should not be more than three or four months.

THE Animal Health Trust has made a research grant to Mr. J. Steele, of Australia, for work at the Trust's Canine Research Station near Newmarket. Mr. Steele's work will be in connexion with the fundamentals of electro-cardiography as applied to domestic animals and with nervous diseases of dogs.

THE Council of the Institution of Mining and Metallurgy is arranging a symposium on the "Refining of Non-ferrous Metals" to be held in London on July 7 and 8, thus preceding the Fourth Empire Mining and Metallurgical Congress. The papers to be presented will be issued as preprints, so that most of the time available at the meeting may be devoted to discussion. Further information can be obtained from the Secretary, Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.

THE third annual Electronics Exhibition organised by the North-West Section of the Institution of Electronics will be held in the College of Technology, Manchester, during July 20–22. There will also be an exhibition of scientific films arranged by the Manchester Scientific Film Society. Admission to the Exhibition will be by ticket only, obtainable from Dr. J. A. Darbyshire, 'Melandra', 1 Kershaw Road, Failsworth, Manchester.

A SUMMER school for youth leaders is being held at Haywards Heath, Sussex, during July 26–August 1, under the auspices of the National Association of Girls' Clubs and Mixed Clubs. The theme of the conference will be "The Club Programme and Informal Education" and it will be directed by Dr. J. Macalister Brew. Further information can be obtained from the Education Secretary, National Association of Girls' Clubs and Mixed Clubs, 30–32, Devonshire Street, London, W.1.

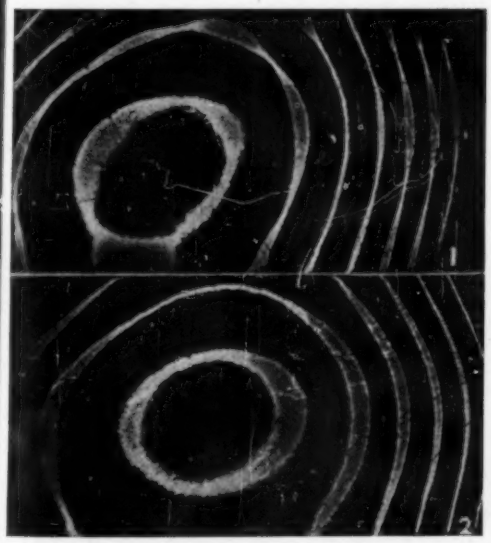
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Application of Multiple-Beam Interferometry to the Study of Oscillating Quartz Crystals

We have succeeded in applying multiple-beam interference methods to the study of the surface movements of oscillating quartz crystals, and the striking results obtained indicate that this has opened up a considerable field for investigation. The technique is simple. The quartz crystal (kindly prepared for us by Dr. W. G. Radley of the Post Office Research Laboratory) was polished to a slightly higher degree than that usually adopted for oscillators, in order to give sharp interference fringes. It was silvered very lightly on one side, and on the opposite face with a high reflecting silver layer. The high reflecting face was placed resting in contact with a silvered optical flat, and electrical connexion made (by gentle contact) between the lightly silvered face of the crystal and the silver layer on the flat. The two connecting leads were taken to an oscillator circuit. There were no constraints on the crystal.

On illumination with correctly collimated monochromatic light (5461 A.), sharp multiple-beam Fizeau fringes form in the air film between the surfaces of the crystal and the flat, providing the crystal is not oscillating. The particular crystal used was rectangular, 3 cm. × 1 cm., and about 3 mm. thick. The final optical polish was such that the face in contact with the flat had a slight curvature, as a result of which the field of view, when the crystal was not oscillating, was covered by a few sharp, yet highly dispersed approximately circular fringes. When oscillations are excited, the fringes take on the remarkable appearance shown in the accompanying reproductions. Fig. 1 shows about three-quarters of the crystal surface, the remainder (the left-hand quarter) being obscured by the particular microscope stage available. One can see in a striking manner the whole distribution of oscillation on the crystal surface. More than one type of oscillation can, of course, be excited, and in that illustrated in Fig. 1 it can be clearly seen that there exist clear-cut nodal lines which are roughly the diagonals of the rectangular crystal face, forming a St. Andrew's cross. Other secondary features are readily interpreted from the interferogram, the fringe-width at any point being an exact measure of the local amplitude of oscillation. In Fig. 2, an oscillation of another type is illustrated, different nodal regions being readily discernible. Under the particular excitation conditions employed here, observed amplitudes vary from zero to a maximum of about 750 A.



A remarkable feature is the extreme sharpness of the fringes in the nodal positions. It is evident that in these regions the fringes remain quite undisplaced over the length of the time of exposure (several minutes), and indeed from visual observation they appear to remain quite still indefinitely. An amplitude of oscillation of only $\lambda/100$ can certainly be detected even with the relatively imperfectly surfaced crystal used here. This quantity is about 50 A.; hence the nodal regions have certainly less amplitude than this small amount, if any at all, and may quite possibly be at rest to within the dimension of the crystal lattice spacing. It should be possible to test this conjecture by using the high-dispersion crossed fringe technique already in use in this laboratory; but such an approach requires a higher surface finish than that of the crystal used. When sufficiently well-worked surfaces become available, this sensitive technique will be adopted.

A surprising feature is the complete stability of the fringe pattern given by the oscillating surface, particularly when the sensitivity of the multiple-beam fringes is recalled. It is clear to us that an intensive programme of investigation is called for, and this is being undertaken. We intend also to attempt to extend the technique by the application of stroboscopic methods of illumination. We note here that some earlier attempts in this direction have been reported, using two-beam interference methods (see Vigoureux, "Quartz Oscillators and their Applications" (1939)), but of course, as is always the case, the sensitivity of a two-beam interference method is not to be compared with that of the far more powerful multiple-beam technique.

A fuller report, including details of measurements, will be communicated elsewhere at an early date.

S. Tolansky
W. Bardsley

Royal Holloway College,
Egham, Surrey.
Feb. 20.

Transfer Rates in Liquid Helium Films

The superfluidity of liquid helium II can be very conveniently studied by making observations on the flow of the thick mobile films ('Rollin films'[1]) which cover all surfaces in contact with the liquid. In previous investigations of these films by Daunt and Mendelssohn[2], the rate of flow was observed to be almost independent of such factors as the pressure head or the height of the film, and varied only with the temperature, rising from zero at the λ-point to $7{\cdot}5 \times 10^{-5}$ cm.^{3}/sec. per cm. width of film below 1·5° K. We have extended these investigations and

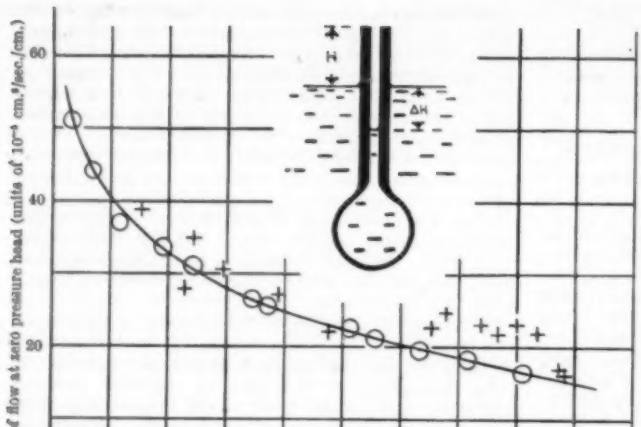


Fig. 1. ⊙, filling; +, emptying; temperature, 1·347° K.

have observed: (*a*) that with some experimental arrangements the rate of flow varies considerably with the height of the film; (*b*) that there is an effect which simulates a dependence upon the pressure head; and (*c*) that much higher rates of flow, up to 10^{-2} cm.^{3}/sec./cm., can occur.

In the first type of experiment an apparatus such as that shown in Fig. 1 was used. It consisted of a straight glass capillary of internal diameter 0·54 mm., open at its upper end and blown out into a closed bulb of diameter 3 cm. at its lower end. The capillary was partially immersed in a bath of liquid helium II, and that part of the glass surface protruding above the bath became covered with the film. When the vessel was raised or lowered, transfer took place through the film until the inner meniscus returned to its equilibrium position very close to the bath-level. The rate of filling was independent of the difference in height, ΔH, between the two levels, but the rate of emptying decreased as ΔH decreased in such a way as to suggest that the determining factor was not the pressure head but the height H of the top of the capillary above the higher of the two levels. During a filling the higher level was, of course, the bath-level which remained stationary so that H remained constant; but during an emptying the higher level, being the inner level, was falling rapidly and H was increasing as ΔH was decreasing. The rate of emptying extrapolated to $\Delta H = 0$ was approximately the same as the rate of filling; but both quantities varied rapidly with the height of the film, H, as will be seen from Fig. 1. This variation with H might be an effect depending upon the length of the film as in the case of viscous flow through tubes, but it is also possible, as suggested by Bijl, de Boer and Michels[3], that the thickness of the film is a function of height. The rate of transfer for a particular value of H varied in a complicated way with the radius of the capillary and even with the volume of the bulb, which suggests that the driving force was not a hydrostatic pressure but a temperature difference arising from the various thermal effects which are known to occur in liquid helium II.

It was, in fact, possible to initiate these high rates of transfer thermally, using the apparatus shown in Fig. 2. The small glass Dewar flask had a ground lip against which was pressed a glass cap with a ground flange. The only communication between the helium bath and the inside of the Dewar flask was via this ground joint, but the width of the gap was much greater than the thickness of the film. Heat was supplied electrically to the inside of the Dewar flask, so that the temperature there rose above the bath temperature and consequently liquid flowed into the flask via the film because of the thermomechanical effect[4]. The temperature difference associated with this flow was measured by means of two phosphor-bronze resistance thermometers, one inside the Dewar flask and the other in the bath. A set of readings was taken for a constant value of the film height, H, and the rate of flow was always measured when the flask was filling and the inner level was within a few millimetres of the bath-level. Fig. 2 shows such a set of readings for a film height of 0·9 cm. It will be seen that the flow became saturated

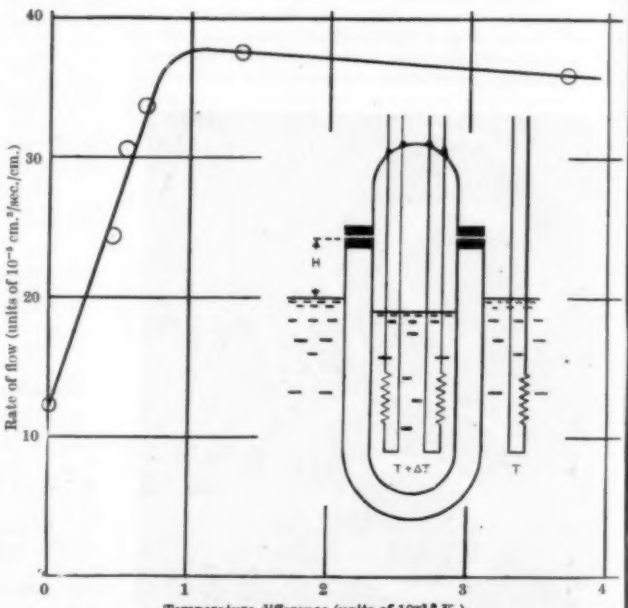


Fig. 2. Height of film, H, 0·9 cm. Temperature, 1·49° K.

at about 38×10^{-5} cm.³/sec./cm. and then began to decrease slowly, presumably because evaporation of the liquid inside the Dewar flask was not entirely prevented by the ground joint. Preliminary measurements have shown that the maximum rate of flow is a function of the height of the film, being only about 26×10^{-5} cm.³/sec./cm. for a film of height 4 cm. In order of magnitude these rates of flow agree satisfactorily with the data of Fig. 1.

It is worth noticing that saturation occurs at a temperature difference of approximately 10^{-3} ° K. which, according to H. London's[5] thermodynamic formula, corresponds to a thermo-mechanical pressure head of only 3 cm. of helium at this temperature. When no electrical power was supplied, a transfer of 12×10^{-5} cm.³/sec./cm. was observed and was probably caused by unwanted heat inflow to the system. It was not possible, however, to decide whether this transfer took place under zero temperature difference or whether it required a temperature difference of the order of 10^{-4} ° K.

I should like to thank Prof. J. F. Allen for valuable help and discussion.

K. R. Atkins

Royal Society Mond Laboratory,
Cambridge.
April 28.

[1] Rollin, B. V., Actes du 7e Cong., intern. du Froid. La Haye—Amsterdam, 1, 187 (1939).
[2] Daunt, J. G., and Mendelssohn, K., *Proc. Roy. Soc.*, A, **170**, 423, 439 (1939).
[3] Bijl, A., de Boer, J., and Michels, A., *Physica*, **8**, 655 (1941).
[4] Daunt, J. G., and Mendelssohn, K., *Nature*, **143**, 719 (1939).
[5] London, H., *Proc. Roy. Soc.*, A, **171**, 484 (1939).

Diffraction of Light by Very High Frequency Ultrasonic Waves

In two recent notes[1], we reported that ultrasonic waves of frequencies as high as 100 Mc./sec. were generated. The diffraction patterns produced by such waves were found to exhibit interesting features. Since then, by using a tourmaline plate and specially designed circuits, we have been able to push up this frequency to nearly 180 Mc./sec., and to study the diffraction effects produced when progressive waves of such high frequencies are maintained in a column of water. Results for the velocity of sound, measured at two different frequencies, are given below. In obtaining these, it has been assumed that the velocity in water is 1,504 metres per second at 15 Mc./sec. and 26·5° C. If the slightly higher temperature of the medium when the highest frequency is used is taken into account, it will be noticed that there is no dispersion of ultrasonic velocity.

It is well known that the first-order lines on both sides are easily obtained at normal incidence when low frequencies are used, and we have found in our earlier work that this feature persists even at 50 Mc./sec. Moreover, when the crystal is tilted, the line on the appropriate side increases in intensity and attains a maximum at the corresponding reflexion angle. The line on the opposite side decreases in intensity but generally does not vanish altogether, showing that if we regard the phenomenon as a reflexion, the angular region in which it occurs when moderate frequencies are used is not at all sharp. In the present experiments, we have made special arrangements to reduce the power supplied to the crystal at moderate frequencies to such an extent that the first-order diffraction lines obtained are as weak as those obtained at 177·2 Mc./sec. Even under such conditions, both lines appear at normal incidence and they exist simultaneously over practically the entire range as the tilt of the sound wave-front is varied from the reflexion position on one side to the reflexion position on the other.

On the other hand, the diffraction patterns at the very high frequencies employed disappear altogether when the sound wave is exactly normal to the incident light. The crystal holder has to be tilted to the correct angle on one side or the other so that the first-order diffraction line on that side may appear. At these high frequencies, the first-order lines on both sides are never present simultaneously. It may even be said that the appearance of the first-order line is quite critical. The tilt angle measured in our experiments with different frequencies has been found to be in agreement with the value derived from the equation $\lambda/\lambda^* = 2\mu \sin\theta$. In accordance with this formula, we find that the sound wave-front has to be tilted from the normal position by 1° 29′ in the case of 177·2 Mc./sec. in order that the first-order line on one side may appear. So small a deviation as about 8′ from this position results in complete disappearance of the line. The wave-length of sound in water corresponding to 177·2 Mc./sec. employed in the present investigation is 0·000849 cm., which is only about fourteen times as large as the wave-length of sodium light.

Order of harmonic	Frequency, ν (megacycles per sec.)	Fringe width, d (cm.)	ν/d	Velocity (metres per sec.)	Temp. (° C.)
9	15·29	0·1237	123·6	1504	26·5
83	140·9	1·140	123·6	1504	26·5
107*	177·2	1·441	122·9	1511	27·9

* The plate distance in this case is slightly different from that adopted in the other two.

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[1] *Nature*, **158**, 484 (1946); **159**, 266 (1947).

A New Hot-Wire Vacuum Gauge

It is known that the range of a hot-wire vacuum gauge may be extended to 10 mm. mercury pressure or above, if by some means the current supplied to

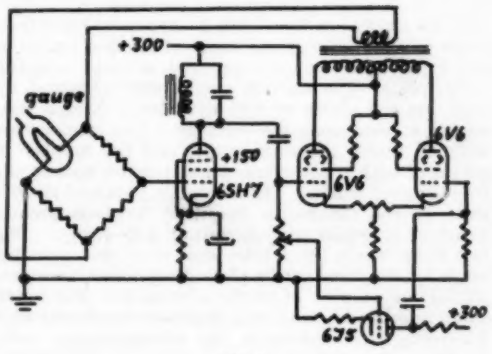

Fig. 1

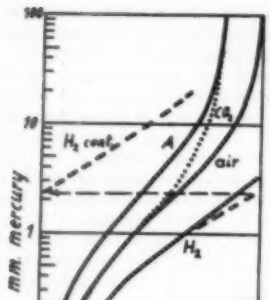

Fig. 2

the wire is increased with increasing pressure[1,2]. Attempts have been made to do this with the aid of automatic devices. Such a gauge becomes easier to handle, and there is then no danger of overloading. One of these circuits (suggested in principle by Mr. G. von Dardel) (Fig. 1) consists of an amplifier tuned on 800 c.p.s. A regenerative feed-back is provided by a bridge containing the hot wire. The amplitude of oscillations adjusts itself to keep the temperature of the wire approximately constant at all pressures. The amplitude is read by a diode circuit. Two ranges of sensitivity are provided. The output meter is protected from dangerous overloading by a rectifier which, however, distorts the readings slightly.

It is essential to use a very thin wire. An extended spiral of 0·01 mm. tungsten wire is employed here. The length is approximately 5 cm., cold resistance 90 Ω, working resistance about 120 Ω. The heating current ranges from 4 to 35 mA. The spiral is mounted inside a capillary in order to save space. Calibration curves are plotted in Fig. 2.

The gauge responds immediately to changes in pressure. In cases where for some reason it is not suitable to use a gauge with a fluid, the hot-wire gauge can be used.

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[1] Knudsen, M., *Ann. d. Phys.*, **34**, 593 (1911).
[2] Rittner, E. S., *Rev. Sci. Instr.*, **17**, 113 (1946).

Electron Tracks in Photographic Emulsions

Electron range. In a recent note[1], R. W. Berriman reported on a new photographic emulsion with which electron tracks can be recorded. Attempts have been made to relate energy and range of electron tracks in this type of photographic material, referred to as the *NT2a* plate. The electron tracks were obtained by exposing the plates to heavily filtered X-rays generated at increasing kilovoltages. The tracks were scanned under the microscope, and the number of grains of each track counted was plotted against the frequency of tracks. The curves so obtained show a shift of the maximum frequency towards greater numbers of grains with increasing kilovoltage. In a few cases where the tracks were at almost glancing angle to the plane of the plate, length measurements of the curved path of tracks were made. The maximum number of grains and lengths of tracks for each kilovoltage are shown in the accompanying table (columns 2 and 3).

1 kV.	2 Max. number of grains	3 Range in microns (curved path)	4 Schonland and Varder (calc. in microns)	5 Column 3 × 1·4 (curved path in microns)
35	13	8	6·1	8·4
50	18	14	10·6	14·8
65	16	—	16·7	23·4
69*	18	—	18·6	26·0
80	—	—	23·1	32·0
100	18	—	—	—
130	28	35	—	—
200	27	—	—	—

* This refers to monochromatic radiation (K_α of platinum).

It will be seen from this table that the maximum numbers of grains counted between 50 and 100 kV. are almost identical. A possible explanation might be the rising proportion of Compton recoil electrons, which have on the average a considerably shorter range than the photo-electrons. The range quoted in column 3 refers to the curved path of the electron tracks. The thickness of various metals necessary to stop electrons of different velocities was determined by Schonland[3] and Varder[3]. This was found to be dependent only on the mass per unit area. The range values of Schonland and Varder were converted into lengths in microns for the mass per unit area of *NT2a* emulsion, and these values are quoted in column 4. The curved paths in the metal should be on the average some 40 per cent greater than the thickness of the foil[4]. Column 5 shows the values of column 4 multiplied by 1·4.

From the values in column 4 and from the explanation regarding the constancy of grain numbers between 65 and 100 kV., it can be concluded that the maximum energy of electrons which can be recorded with the *NT2a* emulsion will be at about 80 kV. This figure might serve as a guide until more accurate measurements have been made by means of an electron spectrograph.

Fig. 2 Fig. 1 Fig. 4

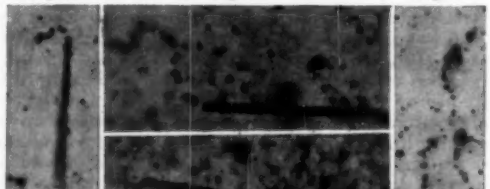

Fig. 3

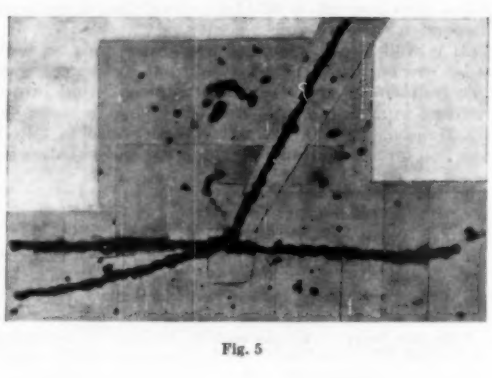

Fig. 5

Electron track records in radioactive decay. NT2a emulsions were soaked in dilute thorium and uranium nitrate solutions, and electron tracks were recorded at the origin of alpha-tracks. Figs. 1 and 2 show photomicrographs of alpha-tracks of uranium I with beta-tracks probably due to the decay of uranium-X_1. The beta-ray energy (Fig. 1) should, according to the table, correspond roughly to 35 kV. Fig. 3 represents an alpha-track due to thorium-C, and the beta-particle is due to the parent element thorium-B, which has been ejected before the alpha-emission. A second beta-particle is believed to be seen as being ejected from the same origin. This may be attributed to the beta-emission from thorium-C″. Fig. 5 is a photomicrograph-mosaic of a plane-projection of a three-dimensional radiothorium star at the origin of which an electron track is seen. The second electron track visible in this photograph may be the end of a track of an electron of higher energy arising from the same origin.

Auger tracks. While scanning the electron tracks it was observed that some tracks show clumping of grains at the beginning and at the end of tracks (see arrows in Fig. 4). This phenomenon can probably be attributed to the Auger effect. Although the specific ionization is greater at the end of the tracks, in some cases branching of short secondary tracks will be recorded in the emulsion by heavier ionizations at the beginning of the tracks.

I am indebted to Messrs. E. B. Kennedy and G. P. Cooke for their assistance in this work.

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[1] Berriman, R. W., *Nature* [**161**, 432 (1948)].
[2] Schönland, *Proc. Roy. Soc.*, A, **104**, 235 (1923); **108**, 187 (1925).
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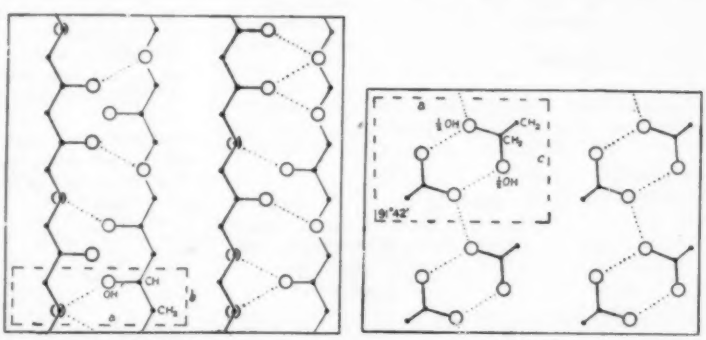
Crystal Structure of Polyvinyl Alcohol

It has often been said (by me[1] as well as by others) that the molecular repeat distance (from X-ray diffraction photographs) of polyvinyl alcohol—2·52 A.[2]—indicates not only that the chain has a simple plane zigzag configuration, but also that all the hydroxyl groups (in the section of a molecule in one crystallite) lie on the same side of the zigzag plane. This is not necessarily true; so far as X-ray diffraction is concerned, the observed repeat distance is equally compatible with a molecular structure in which hydroxyl groups are randomly placed in left- and right-hand positions. This possibility was not considered until recently; it was assumed that the high degree of crystallinity of polyvinyl alcohol implied regularity of molecular structure. Recently, however, it has been found[3] that interpolymers of ethylene and vinyl alcohol are crystalline; thus hydroxyl groups may replace hydrogen atoms at random on a carbon chain without destroying crystallinity; the high crystallinity of polyvinyl alcohol cannot, therefore, be regarded as evidence against the idea of stereochemical irregularity in this molecule.

To determine whether the hydroxyl groups are randomly or regularly placed, the interpretation of X-ray diffraction patterns of polyvinyl alcohol fibres has been considered in detail. In agreement with Mooney[2], a two-molecule monoclinic unit cell is found to account for the positions of X-ray reflexions; this cell has $a = 7{\cdot}81$ A., $b = 2{\cdot}52$ A., $c = 5{\cdot}51$ A., $\beta = 91°\ 42'$; these figures agree fairly well with those of Mooney, who, however, gives $\beta = 90°$. No structure embodying regular molecules gave correct relative intensities for the X-ray reflexions; all possible arrangements (including that proposed by Mooney) and all possible molecular parameters were considered. But a particular arrangement of molecules with hydroxyl groups randomly placed in left- and right-hand positions accounts in a highly satisfactory way for the entire X-ray diffraction pattern: calculated intensities agree very well with those observed. This arrangement has the symmetry $P2_1/m$ with C (of CH_2) at 0·190 *a*, 0·250 *b*, 0·806 *c*, C (of CH) at 0·277 *a*, 0·750 *b*, 0·708 *c*, half the oxygen atoms at 0·451 *a*, 0·750 *b*, 0·782 *c*, and the other half at 0·267 *a*, 0·750 *b*, 0·450 *c*. The arrangement, which is illustrated in the accompanying projections, may be described as a layer structure; a double layer of molecules is held together by hydroxyl bonds; between one double layer and the next the weaker Van der Waals forces operate. The hydroxyl bond distances (2·8 and 2·9 A.) are greater than in pentaerythritol[4] and resorcinol[5] (2·7 A.) and therefore the bonds are presumably weaker than in those substances; this is perhaps connected with the fact that owing to the random positions of the OH groups, some of the possible bonds are not made at all, while in other cases an OH group is faced with too many possibilities (up to four) of hydroxyl bond formation.

This is an example among high polymers of the sort of randomness which has been reported recently by Clews and Cochran[6] in a monomeric crystal (2-amino-4-methyl-6-chloro-pyrimidine); but in view of the difference of size of the hydroxyl group and the hydrogen atom, polyvinyl alcohol is a more extreme case. The implications in the theory of crystallization (or non-crystallization, as the case may be) of high polymers have been referred to in an earlier communication[3]. Here, I need only remark that polyvinyl acetate, from which polyvinyl alcohol is prepared, probably has a corresponding (stereo-



c-Projection *b*-Projection

Dotted lines, hydrogen bonds

chemically random) molecular structure, but, unlike polyvinyl alcohol, does not crystallize; this is presumably because the difference of size between acetate groups and hydrogen atoms is much too great for them to occupy equivalent positions in a crystal structure.

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The Tollens Naphthoresorcinol Reaction for Uronic Acids

The mechanism of colour production in the Tollens test[1] for glucuronic acid is not definitely known, and since this reaction is frequently used for the determination of glucuronic acid in biological materials[2], an attempt should be made to understand its chemistry. Some of our preliminary results to this end are now reported here.

Since the reaction is carried out by heating naphthoresorcinol (1 : 3-dihydroxynaphthalene) and glucuronic acid in 5–6 *N* hydrochloric acid, furfural may be formed which may condense with naphthoresorcinol to give a pigment. We find, however, that furfural gives a different and less intense colour than glucuronic acid.

Mayer, Bloch and Chaffee[3] in a brief abstract suggested that the pigment of the Tollens test may be a xanthene derivative. Our observations (see below) appear to support this view, and the following mechanism is suggested for the Tollens reaction (cf. the formation of pyronine and phthaleine dyes).

Some of our observations were:

(*a*) Heating naphthoresorcinol, m.p. 119°, and *d*-glucurone, m.p. 176° (or *d*-galacturonic acid), together in the dry state at a low temperature, 100–120°, yields the same dark-blue solid as obtained in the Tollens reaction. In ethanol the blue solid obtained either way shows spectral absorption bands at 595, 335, 302 and 243 mμ.

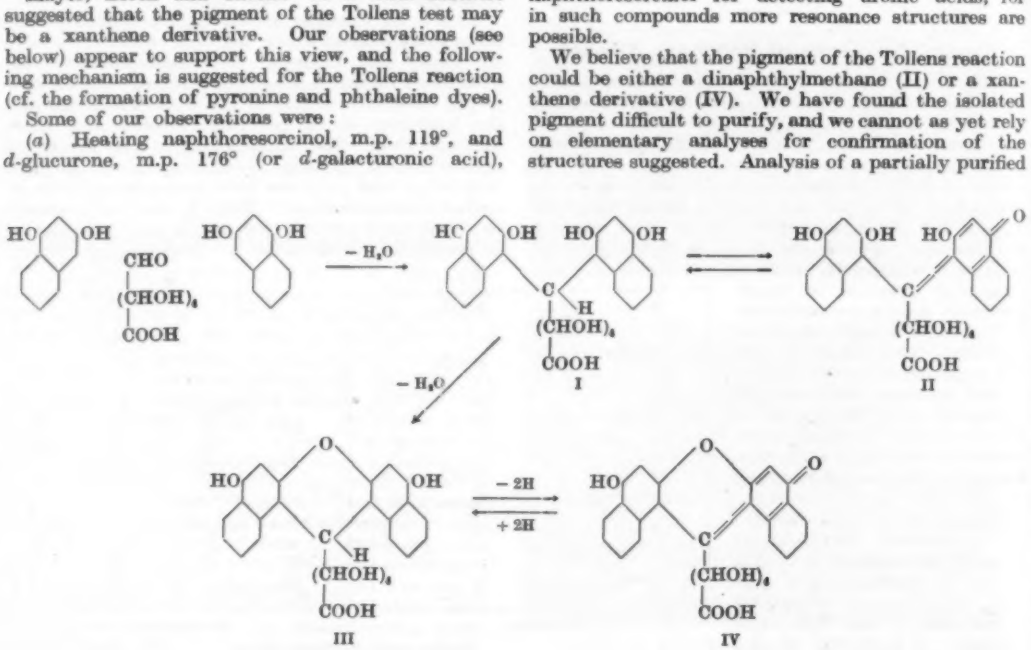
(*b*) If dry naphthoresorcinol and *l*-menthyl-glucuronide are heated together, no blue solid is obtained unless crystalline oxalic acid is added to the melt. This experiment suggests that the aldehydic group of the uronic acid must be free for pigment formation.

(*c*) The solid pigment is soluble in dilute alkali, from which it is precipitated by acid as dark-blue flocks, that is, it is acidic.

(*d*) A solution of the pigment is readily decolorized by sodium hydrosulphite, forming the leuco dye I or III, and the colour can be restored (to the quinones II or IV) by an oxidizing agent such as chloramine-*T*.

(*e*) If naphthoresorcinol is replaced in the Tollens reaction by monocyclic *m*-dihydric phenols such as resorcinol or orcinol, only very weak colours are obtained unless an oxidizing agent is also present. Thus if orcinol and glucurone are heated in 5–6 *N* hydrochloric acid, on extraction with amyl alcohol a weak green colour is obtained; but if the reaction is carried out in the presence of chloramine-*T*, a very intense green results. To obtain an intense colour with naphthoresorcinol an external oxidizing agent does not appear to be necessary, although Mayer, Bloch and Chaffee[3] state that the colour intensity is increased by potassium persulphate. It should be noted that the two possible formulæ, II and IV, suggested for the naphthoresorcinol pigment could form several resonance structures; these would tend to stabilize the pigment and render its production from the leuco-form relatively easy. This suggests that *m*-diols of polycyclic hydrocarbons such as anthracene-1 : 3-diol may be even better than naphthoresorcinol for detecting uronic acids, for in such compounds more resonance structures are possible.

We believe that the pigment of the Tollens reaction could be either a dinaphthylmethane (II) or a xanthene derivative (IV). We have found the isolated pigment difficult to purify, and we cannot as yet rely on elementary analyses for confirmation of the structures suggested. Analysis of a partially purified



sample gave C, 63·4; H, 3·8 per cent; $C_{16}H_{22}O_{10}$ (II) requires C, 63·2; H, 4·45 per cent; and $C_{16}H_{16}O_8$ (IV) requires C, 65·55; H, 4·2 per cent.

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Feb. 3.

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[2] For example, Hanson, S. W. F., Mills, G. T., and Williams, R. T., *Biochem. J.*, **38**, 274 (1944).
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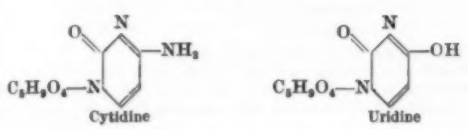
Separation of Pyrimidine Nucleosides by Synthetic Resin Ion-Exchangers

Four nucleosides—guanosine, adenosine, cytidine and uridine—are formed in the hydrolysis of yeast ribonucleic acid by aqueous pyridine, and Bredereck *et al.*[1] have described a method of isolating the nucleosides from the hydrolysate. Although this method is adequate for the production of guanosine and adenosine, we have been unsuccessful in isolating the pyrimidine nucleosides in the pure state and in good yield by this method, and believe this to be due to the method of isolation adopted by Bredereck.

In consequence, a technique has been developed for the separation of cytidine and uridine using a cation-exchange resin.



Cytidine Uridine

Cytidine would be expected to be retained by a cation-exchange resin due to the basic amino-group ($pK'_b = 9{\cdot}78$)[2]. Uridine, on the other hand, would be expected to have little or no tendency to remain on the resin as the enolic hydroxyl group is acidic ($pK'_a = 9{\cdot}17$)[3]. 'Zeo-Karb 215' was selected for trial because of its strong proton-donating sulphonic acid groups and because of its stability to alkaline solution (*v. infra*). The above expectations were realized when aqueous solutions of cytidine and uridine were separately percolated down columns of 'Zeo-Karb 215'. In the former case, cytidine was afterwards eluted from the column by dilute aqueous ammonia.

A mixture of cytidine and uridine in aqueous solution (0·05 *M* with respect to each nucleoside) was therefore passed down a column of the same resin.

The percolate and aqueous washings were evaporated to dryness, giving crystalline uridine (*c.* 99 per cent recovery), m.p. 162–165° C. The column was eluted with *N*/10 aqueous ammonia and the eluate evaporated to dryness, giving crystalline cytidine (71–78 per cent recovery), m.p. 208–211° C.

An attempt is being made to obtain the pyrimidine nucleosides from deoxyribonucleic acid using the above technique. A fuller account of this work will be published elsewhere.

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March 2.

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Isolation and Separation of the Pyrimidine Nucleosides of Yeast Ribosenucleic Acid

Improved methods have been sought for the isolation and preparation of the purine and pyrimidine nucleosides of yeast ribosenucleic acid as a preliminary to the study of the constitution of the nucleic acids of normal and malignant tissues.

Bredereck *et al.*[1] were able to prepare adenosine and guanosine by enzymatic or aqueous pyridine hydrolysis of the acid, and claimed to have separated cytidine and uridine. The yields of these latter were low and no characterization data were given. Gulland and Smith[2] failed to obtain cytidine by Bredereck's method, and the yield of uridine was augmented by deamination of any cytidine present. Isolation of the four nucleosides from the same nucleic acid sample has not hitherto been satisfactorily achieved even from hydrolysates of as much as 100 gm. nucleic acid.

Preliminary experiments showed that cytidine and uridine could be satisfactorily isolated and separated in one operation, not only from artificial mixtures, but also from the pyrimidine nucleoside fraction of the nucleic acid hydrolysate. Cytidine, having a basic amino group ($pK = 4{\cdot}22$)[3], is retained from dilute aqueous solution on percolation through a column of ion-exchange resin 'Zeo-Karb 215', activated by hydrogen ions. Uridine, on the other hand, with an acidic hydroxyl group ($pK = 9{\cdot}17$)[3] is not so retained.

Hydrolysis of 20 gm. yeast ribosenucleic acid (Pharmaco-Chemical Products Co.) with 50 per cent aqueous pyridine, by the method of Bredereck *et al.* (*loc. cit*), gave comparable yields of guanosine (m.p. and mixed m.p. 237–240°) and adenosine (m.p. and mixed m.p. 228–229°). The residue was hydrolysed with 2 per cent sulphuric acid, and the liberated purine bases removed with silver sulphate. Excess silver ions were precipitated as silver sulphide, and sulphate ions as barium sulphate. Percolation of the solution (1 l.) through a column containing the minimum quantity of prepared resin and concentration *in vacuo* of the effluent and 1 l. water washings gave 2·4 gm. uridine, as colourless needles (m.p. and mixed m.p. 165–166°; $[\alpha]_D^{22} + 10° \pm 2°$; *c*, 1·6245 in water). Elution of the exchanger with 2 per cent aqueous pyridine gave 150 mgm. cytidine (crystallized as sulphate, m.p. and mixed m.p. 224–225° (dec.); $[\alpha]_D^{11} + 37{\cdot}5 \pm 2°$; *c*, 1·498 in 1 per cent aqueous sulphuric acid).

A volumetric procedure has been developed for the estimation of dilute aqueous solutions of uridine and/or cytidine which may be used to determine the extent of elution or degree of exhaustion of the exchanger.

These experiments are described in detail in a paper submitted and accepted for publication in the *Journal of the Chemical Society* on January 20, 1948.

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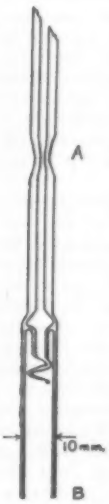
Microsynthesis of C^{14}-Labelled Ethyl Iodide

CARBON dioxide labelled with C^{14} can be converted in good overall yield to ethyl iodide by way of acetylene and ethylene on the scale of about 10 micromoles. Acetylene can be produced from carbon dioxide[1] in 90–95 per cent yield, and it may be reduced almost quantitatively to ethylene by the method of Traube[2,3], in which it is shaken for an hour with a large excess of freshly prepared chromous chloride solution at room temperature. The chromous chloride solution is prepared by the rapid reduction of a solution of 1 part green chromic chloride hexahydrate in 2 parts 25 per cent hydrochloric acid with zinc wool, until the solution turns almost a copper sulphate blue. About 0·4 ml. of this solution is pipetted into a glass reaction vessel (see diagram), frozen in liquid nitrogen and evacuated. The acetylene is condensed into the tube which is then sealed off at *A* and allowed to warm to room temperature. After agitation for an hour, carried out by intermittent rotation about its axis of the reaction vessel held horizontally, the vessel is sealed on to the high vacuum apparatus at *B* and the break-seal opened. All the dissolved gas is boiled from the chromous chloride solution, and ethylene condensed at liquid nitrogen temperature into a trap connected with a McLeod gauge, water and any residual acetylene being held back in a U-tube at liquid oxygen temperature. The yield in terms of standard gas volume is 96–98 per cent in this stage, and the remaining few per cent of acetylene can be recovered from the oxygen-cooled trap.



The direct addition of hydrogen iodide to ethylene is not easy, but can be carried out with about 90–95 per cent yield on the 10-micromole scale by sealing up ethylene with a few drops of saturated hydriodic acid in a tube similar to that used for reduction of acetylene but of about half the internal volume. The closed tube is then heated for one hour at 144° C. (boiling *o*-xylene). After the break-seal has been opened, the whole contents of the tube are distilled into excess 50 per cent caustic soda, from which ethyl iodide vapour can be recovered, most of the water vapour being held back at −78° C., and the ethyl iodide vapour finally dried over about 100 mgm. of anhydrous magnesium perchlorate for five minutes.

The synthesis is intended for use with radiocarbon dioxide of the highest obtainable specific activity; but in order to obtain a preliminary check on the yield in terms of radioactivity, several samples of C^{14}-labelled carbon dioxide of exceedingly low activity were converted to ethyl iodide by the method, this ethyl iodide being burnt and the carbon dioxide from it introduced into a Brown and Miller type β-counter[4]. It was found that whereas overall yields for $CO_2 \rightarrow C_2H_5I$ were about 80 per cent in terms of gas volume measurements, in terms of radioactivity they were generally some 10 per cent lower. About half the loss in radioactivity was found to occur in the stage $CO_2 \rightarrow C_2H_2$, and the other half in the stage $C_2H_4 \rightarrow C_2H_5I \rightarrow CO_2$. No loss of activity at all occurred in the stage $C_2H_2 \rightarrow C_2H_4$. In two particular experiments, the overall volume yields were 83·5 and 84 per cent, and the yields calculated from radioactivity measurements, 72 and 75 per cent. The activities of C^{14} available in each experiment were only about three times the background of the counter and were insufficient to pursue further the small losses, the first of which was probably due to an unidentified exchange reaction. In fact, the total amount of C^{14} available was 2×10^{-3} microcuries, of which half had to be used for calibration of the counter.

Catalytic reduction of acetylene to ethylene has been found to be possible on this scale, and yields are about 75 per cent. The method of preparation of the palladized palladium catalyst is critical, however, and it is easily poisoned. Chromous chloride reduction is much to be preferred.

We wish to acknowledge grants from the Therapeutic Research Corporation, the Royal Society and the Central Research Fund of the University of London, and to thank the Medical Research Council for grants and for a specimen of radioactive barium carbonate. One of us (R. G.) is a Keddey Fletcher-Warr student of the University of London.

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Effect of Insulin on Intestinal Glucose Absorption in Alloxan Diabetic Rats

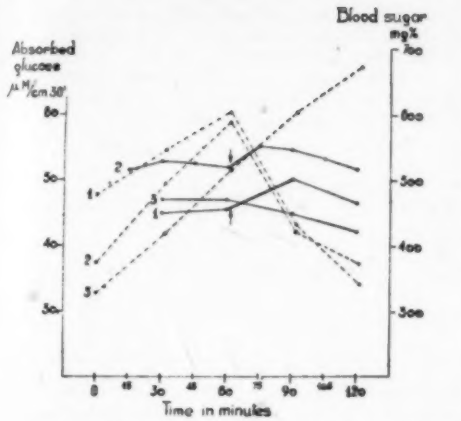
INTESTINAL absorption of glucose is increased in the diabetic rat[1,2]. According to Laszt and Vogel[2], this increase is not observed when alloxan diabetic rats are submitted to insulin treatment, suggesting that insulin has an inhibiting action on intestinal glucose absorption.

In the diabetic animal, as a consequence of the lack of insulin, changes are produced in the enzymatic systems, some of which might themselves modify absorption. To determine whether insulin has a direct influence on the mechanism of absorption, we have investigated the intestinal glucose absorption in alloxan diabetic rats before and after intravenous injection of insulin in the same animal, by the Sols and Ponz method of successive absorptions[3].

Diabetes was produced by intravenous injection of 5 mgm. of alloxan per 100 gm. body-weight. The animals were tested four to eight days after this injection. Previous to testing, a blood-sugar level greater than 300 mgm. per cent was recorded.

Within a period of 2½–3 hours, two or four absorption experiments (of 30 and 15 min. duration respectively) were done; then an intravenous injection of 2 units of insulin per 100 gm. body-weight was given, and immediately afterwards further absorption experiments, all other circumstances being kept constant. By way of control, the blood-sugar level was estimated periodically, usually once after each absorption experiment.

As a control of the absorption capacity in diabetic rats during the experimental period (about three



CURVES OF ABSORPTION (———) AND OF BLOOD-SUGAR LEVEL (– – –) IN ALLOXAN DIABETIC RATS.
(1) FOUR ABSORPTION EXPERIMENTS OF 30 MIN. DURATION. (2) EIGHT ABSORPTION EXPERIMENTS OF 15 MIN. DURATION. IN BOTH SETS AN ARROW MARKS INSULIN INJECTION. (3) CONTROL ANIMAL WITHOUT INSULIN INJECTION
THE INTERVALS BETWEEN ABSORPTION MEASUREMENTS (ABOUT 5 MIN. EACH) ARE NOT RECORDED

hours), several animals were examined in the same way, without insulin injection.

The accompanying figure shows three typical cases. These show that the immediate effect of insulin[1,2] is not to produce a decrease of intestinal absorption of glucose in diabetic rats, but rather a slight increase during the first half-hour; this contrasts with the tendency to decrease, with time, shown by diabetic animals[3]. In twelve animals, this increase showed an average value of 8 per cent.

We would emphasize that the maximal absorption does not correspond to a minimal blood-sugar value: one hour after insulin, the blood-sugar level is lower than after half an hour, whereas absorption is already returning to original values.

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Respiratory Quotient of the Mammary Gland

DETERMINATIONS by the arterio-venous method of the respiratory quotient of the lactating udder of the goat[1,2] and cow[3,4,5] have given mean values greater than unity, which have been interpreted[1,2] as evidence of the formation of fat from carbohydrate.

A feature of these studies, commented upon in at least one instance[5], has been the excessive variability of arterio-venous differences in oxygen and carbon dioxide and in the corresponding respiratory quotient values. No undue variability was, however, observed in a small series of determinations carried out on lactating cows in this laboratory[6], in which the blood samples were collected over mercury; in eight experiments in which no detectable hæmo-concentration occurred, the mean respiratory quotient was 1·25 ± 0·12 (95 per cent fiducial limits). Variance has also been diminished by working on anæsthetized goats[3], for which a mean respiratory quotient of 1·09 was obtained. This mean quotient can scarcelybet regarded as significantly greater than unity; but it was raised to 1·18 by application of a correction (incidentally slightly incorrect[7]) for the carbon dioxide supposedly used for the synthesis of urea by the mammary gland. By contrast, values obtained on anæsthetized cows[4] could scarcely be considered as satisfactorily uniform.

The high mammary gland respiratory quotient indicated for the lactating gland by the arterio-venous technique is of obvious interest; but in view of the criticisms which this technique has to face[8,9], and since the high value has not always been confirmed by studies on perfused glands[3,5], it seemed desirable to investigate the question by the tissue slice method, which hitherto has not, so far as we know, been applied to the mammary gland. Accordingly we report below some preliminary results on the respiration and respiratory quotient of mammary gland slices from the lactating rat.

Satisfactorily reproducible slices of this difficult tissue were cut by the microtome of Stadie and Riggs[10], and the respiratory quotient determined by the method of Dickens and Šimer[11] in 3-hr. experiments in bicarbonate-Ringer (*p*H 7·4) containing 0·2 per cent glucose as substrate. The results of twenty-six determinations on slices from ten rats, given in the accompanying table, are satisfactorily consistent and in all cases much greater than unity. Taken together, they are appreciably higher than any of the mean (but not the extreme) values reported for the arterio-venous method. A few determinations by the direct Warburg method in phosphate-Ringer-glucose also gave results well above unity. On the other hand, six experiments (five rats) in bicarbonate medium in which no glucose was present gave a mean quotient of 0·78, so that it seems possible that fat and perhaps protein are being oxidized under these conditions.

The respiration figures are much higher than those reported for pieces (not slices) of rat mammary tissue by Kleiber, Smith and Levy[12] in so far as they are comparable; but our results, like theirs, indicate a tendency for the Q_{O_2} to increase as lactation advances and therefore as the milk yield increases[13] (mean values of $-Q_{O_2}$ (glucose) for slices from the three of our rats killed at three to six days and the remaining

RESPIRATORY QUOTIENTS OF RAT MAMMARY GLAND SLICES

Substrate	No. of rats	No. of determinations	$-Q_{O_2}$		R.Q.	
			Mean	Range	Mean	Range
0·2 per cent glucose	10	26	7·6 ± 0·4	3·5–11·5	1·54 ± 0·03	1·30–1·86
None	5	6	5·0 ± 0·4	4·1–6·3	0·78 ± 0·03	0·71–0·87

Rats: Hooded Norway. Medium: bicarbonate-Ringer (pH 7·4). Temperature: 37° C. Gas mixture: 95 per cent oxygen, 5 per cent carbon dioxide.

seven killed at 15–21 days *post partum* were respectively 5·6 and 8·4; $P = 0{\cdot}03$).

The validity of determinations of respiratory quotient on tissue slices extending over 3-hr. periods has been questioned[14], but we have evidence which indicates that the quotient is high from the outset, so that there is no reason to suppose that our values are far from the truth.

Our results point with satisfactory consistency to a quotient for lactating rat mammary tissue which is clearly much greater than unity, and thus lend needed support to the high values claimed for the lactating bovine udder on the basis of a technique which suffers from many disadvantages. Speculation in detail about the interpretation of these results in terms of postulated reactions occurring in the active mammary gland must await further work, but it seems reasonable to conclude that mammary tissue is noteworthy in its ability to effect considerable synthesis of oxygen-poor substances from carbohydrate *in vitro*. The interesting possibility, thus opened up, of using mammary gland slices for the study of fat synthesis *in vitro* is being further investigated.

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Influence of Solvent Movement on Sedimentation

Due to the fact that in sedimentation the hydrodynamic volume of the particles moves towards the bottom of the vessel, the medium is caused to flow in an opposite direction. The sedimentation volume is the sum of the volume of the sedimenting particles and the volume of the medium which accompanies the particles.

In calculating the rate of sedimentation we use the following symbols: M_I, the molecular weight or particle weight of the sedimenting substance I; v_I, the partial specific volume of I; c_I, the concentration of I in gm./cm.^{3}; Φ_I, the specific sedimentation volume of I in cm.^{3}/gm. substance I; v_1, the partial specific volume of the solvent 1; x, the distance from the axis of rotation; ω, the angular velocity; $s_I = \frac{1}{\omega^2 x} \times \frac{dx_I}{dt}$ = the sedimentation constant relative to the walls of the vessel; $\sigma_I = \frac{1}{\omega^2 x} \times \frac{dX_I}{dt}$ = the sedimentation constant relative to the free solvent; A, the cross-sectional area of the cell. (These magnitudes should be corrected for the shape of the cell so that they hold for a vessel with parallel walls, and for the changes in density and viscosity with pressure, and for the change in the centrifugal force with x.) The sedimentation volume per second is $c_I\Phi_I \frac{dx_I}{dt} \times A$, and the cross-sectional area for the stream of solvent is A minus the area $c_I\Phi_I \times A$ of the sedimenting particles on this level. Therefore

$$\frac{dX_I}{dt} = \frac{dx_I}{dt} - \left(-\frac{c_I\Phi_I}{1 - c_I\Phi_I} \cdot \frac{dx_I}{dt}\right) = \frac{1}{1 - c_I\Phi_I} \cdot \frac{dx_I}{dt}. \quad (1)$$

The centrifugal force per mol is $M_I\left(1 - \frac{v_I}{v_1}\right)\omega^2 x$ if the accompanying solvent has the same density as the free solvent, which generally, and particularly with pure solvents, is very nearly correct. The frictional force per mol is $f\frac{dX_I}{dt}$. Equating these two forces we get,

$$M_I\left(1 - \frac{v_I}{v_1}\right)\omega^2 x_I = f_I \cdot \frac{dX_I}{dt}, \quad (2)$$

$$M_I = \frac{f_I \cdot s_I}{\left(1 - \frac{v_I}{v_1}\right)(1 - c_I\Phi_I)}. \quad (3)$$

In certain circumstances, Φ_I does not change with c_I and the concentration in front of the boundary is constant, σ_I is independent of c_I. Then we have from (1)

$$s_I = \sigma_I (1 - c_I\Phi_I). \quad (4)$$

In this case s_I is a linear function of c_I, and the value extrapolated to infinite dilution is c_I. From the slope of the graph of s_I against c_I we can calculate Φ_I. In Table 1 values of Φ_I are given for some proteins.

Table 1

Protein	Φ_I	Calculated from measurements made by
Serum albumin (horse)	14	v. Mutzenbecher[1]
" " "	10	McFarlane[3]
" " "	10	Johnston and Ogston[3]
Serum globulin (horse)	12	v. Mutzenbecher[1]
" " "	9·6	McFarlane[3]

The stream of liquid causes the sedimentation peak (dc/dx as a function of x) to have a steeper slope towards the solution than towards the solvent when the diffusion is normal and the substance monomolecular. This means that the sedimenting boundary, obtained from the first moment of the peak, does not correspond to the maximum. If $c_I\Phi_I$ is smaller than about 0·1, dx_I/dt can be calculated from the maximum point and c_I put equal to half the concentration of I in that part of the solution where the concentration is unaffected by the diffusion.

The sedimentation volume also has an effect upon the areas of the sedimentation peaks. Let c_I° and c_{II}° be the original concentrations of two macromolecular substances, of which I moves faster than II, and φ_I^{II} the volume of 1 gm. of substance I and the solvent, which moves together with it and which is not combined with II. Behind the faster boundary $c_I = 0$ and

$$c_{II} = \frac{c_{II}^{\circ}}{1 - c_I^{\circ}\varphi_I^{II}} \qquad (5)$$

in the part between the two boundaries where the concentration is constant. Hence $c_{II} > c_{II}^{\circ}$. If we take the amount of I before the faster sedimenting boundary as the difference $\Delta c_I = c_I^{\circ} + c_{II}^{\circ} - c_{II}$, as is usually done in the determination of concentrations from sedimentation diagrams, we get a smaller value than c_I°. From (5) or Δc_I, it is possible to calculate φ_I^{II}.

The same conditions are also obtained if II is a low molecular substance, 2, and this is the explanation for the fact that c_I as calculated is smaller than c_I° in many protein sedimentations. In this case we get the inner solvation, while $\varphi_I^{II} - v_I$ is the total solvation in cm.³ per gm. of substance I. The inner solvation of cellulose nitrate has been determined by H. Sihtola and T. Svedberg[4] by sedimenting cellulose nitrate in a mixture of a solvent and an indifferent liquid.

If the molecules are dissociated into ions, we must also allow for the electric forces. If there are more than two substances dissolved, the calculations are made in the same way but are more laborious.

In Table 2 some values of φ_I^{II} are given.

TABLE 2

Protein I	Protein II	φ_I^{II}	Calculated from measurements made by
Serum albumin	Lactoglobulin	11	Pedersen[5]
"	"	11	Johnston and Ogston[3]
Serum globulin	"	7	"
" "	Serum albumin	10	"
" "	" "	12	McFarlane[2]

Every value is the mean of at least three determinations at different concentrations. From Tables 1 and 2 it is seen that Φ_I is nearly the same as φ_I^{II}, but the values are not good enough for the formulation of definite conclusions. New measurements and a more detailed discussion will be published later.

To Prof. The Svedberg I wish to express my thanks for the privilege of working at this Institute. I am indebted to Prof. Ole Lamm for his interest in this work; I also wish to thank Mr. Evald Hellman for many stimulating discussions.

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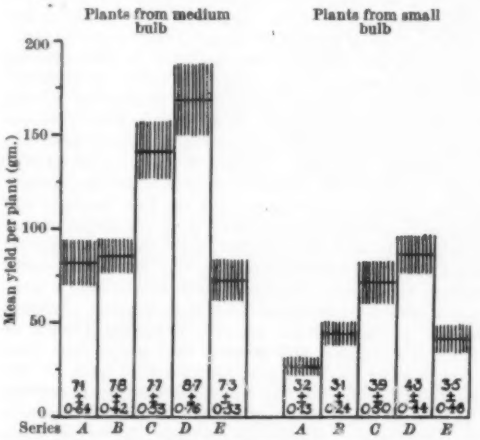
Bulb Formation in the Shallot

As a medium for studying the process of bulb formation, the shallot has certain advantages. It is normally grown from sets, and provided a suitable non-flowering strain is chosen any possible confusion between the effects of treatments used on flowering and bulbing is avoided. In our experiments shallot bulbs of two sizes (medium, mean weight 10·59 gm., and small, mean weight 3·12 gm.) were subjected to the following storage treatments during the winter preceding planting: (*A*) ordinary (laboratory) storage; (*B*) low temperature (0–4°) storage; (*C*) high (88 days at 30°) followed by ordinary temperature; (*D*) low (88 days at 0–4°), followed by ordinary temperature; (*E*) ordinary (88 days), followed by low temperature (71 days at 0–4° C.).

Plants of series *C* were noticeably slow to come into growth, and the plants from the medium-sized bulbs were always more vigorous than those derived from small bulbs. By mid-June the plants of series *C* and *D* were beginning to bulb (the 'low-temperature plants' being slightly more advanced than the 'high-temperature' ones), while all other series were in an advanced state of bulbing. The plants of series *C* and *D* continued to carry vigorous green upright foliage, and were not fit to harvest until August 26, 1946, whereas the other plants were fit to harvest five weeks earlier. Yield data are shown below. It was noticeable that the produce of series *C* and *D* included many very asymmetrical bulbs. These consisted either of one large and one or more smaller bulbs, or of two or more bulbs almost equal in size, invested in a common set of scales.

With both sizes of planted bulbs the treatments have affected bulb growth, but there is some divergence between the results for the plants from the small- and medium-sized bulbs. In both sets of material, series *C* and *D* have given the highest yields. This increased yield is effected by an increase in the weight of the individual bulbs. Treatments *B* and *D* had no effect on the plants from the medium-sized bulbs, but an appreciable effect on those from the small bulbs.



COLUMNS REPRESENT MEAN YIELDS PER PLANT AND THE VERTICAL HATCHING THE STANDARD ERRORS OF THE MEAN. FIGURES IN THE COLUMN REPRESENT THE MEAN NUMBER (WITH STANDARD ERRORS) OF BULBS PER PLANT.

In a subsidiary experiment in which bulbs were stored at high temperature throughout the whole winter, a similar increase in yield and individual bulb-weight was obtained; although in this case the treatment caused an increase in the number of bulbs per plant—probably because common investing scales rubbed off many of the asymmetrical bulbs after drying, so that two or three separate bulbs resulted.

Bulbing in onions is a phenomenon the initiation of which is to a large extent controlled photoperiodically[1], but depending also on the temperature[2–5] and nitrogen supply[6] as well as on the variety. The critical photoperiod differs according to whether the

plants have been derived from sets or seeds, and in the former case the growth and bulbing of the plant are affected by the storage treatments to which the sets have been subjected. Heath and his co-workers[2–5], concerned especially with the effects of storage treatments of onion sets on the 'bolting' of the resulting plants, and confirming and extending the results of earlier workers[1,7], found that high-temperature storage given throughout the winter, or for the last eight weeks, delays ripening, and gives larger yields, whereas high-temperature storage for the first eight weeks has no such effect. These treatments also reduced the incidence of 'bolting', as did storage at 0° either for the whole or the first eight weeks of the winter. The effects of storage treatments on bolting and bulbing were difficult to disentangle; but Heath and Holdsworth[4] concluded that the high-temperature treatments suppress bolting and affect bulbing separately.

So far as the treatments given here parallel those used by Heath in the treatment of onion sets, the results are similar; but with a non-flowering strain of shallot, there is no possibility of any confusion between the effects of the several storage treatments on flowering and bulbing. With the shallot, therefore, we can be sure that we are dealing with a primary effect on bulb initiation and swelling, and not with some secondary effect on these phenomena that operates through the suppression of flowering. If, in the shallot, as in the onion, bulbing is controlled photoperiodically, the effects of these storage treatments would be at least partially explained if their primary effect was in some way to increase the critical photoperiod necessary for bulb initiation. The shallots are grown during a period of lengthening days (April–June), and the effect of an increase in this critical photoperiod would be to delay the onset of bulbing. Further[1], with onions, the greater the excess of the photoperiod experienced over the critical photoperiod required for bulb initiation, the more rapid are the ripening processes. Hence, if the critical photoperiod is increased, but is still less than the photoperiods experienced after bulbing has begun, the difference between the critical and the experienced photoperiods will be reduced, and the processes of bulb ripening retarded, that is, the period of bulb-swelling extended. Delayed bulb initiation, a prolonged period of bulb swelling and delayed ripening are the precise effects on the resulting plants of storage throughout the winter, or for the first part of the winter at 30° C., or for the first part of the winter at 0–4° C. (or for the whole storage period at 0–4° C. with small bulbs) of shallot bulbs before planting. The data available do no more, however, than permit the suggestion that the storage treatments operate on the lines indicated, affecting in some way the critical photoperiod required for the initiation of bulbing in the resulting plants.

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Streptococcus fæcalis in *E. histolytica* Infections

Bacteriological studies conducted upon a series of cases of relapsing amœbiasis showed that changes occurred in the relative distribution of organisms in the fæces during the active stages of the disease[1]. One particular change was the abnormal prevalence of enterococci in dysenteric exudates. In most cases, these enterococci were identified as *Streptococcus fæcalis*.

When a 1 per cent glucose-broth culture or culture-filtrate of certain strains of *Streptococcus fæcalis* was added to a phosphate-buffered suspension of *E. histolytica* in equal volume, the amœbæ were observed to disintegrate in one or two hours. This effect was a specific result of the growth of *Streptococcus fæcalis* in peptone media containing glucose, and was due apparently to some substance or substances formed during the fermentation of glucose. When glucose was fermented by growing cultures of coliform organisms or staphylococci, no such action was observed.

The complete identity of the metabolites which are toxic to *E. histolytica* has not as yet been ascertained, but the properties are consistent with a heat-stable, water-soluble substance not readily adsorbed on surfaces. Lactic acid[2] shows a similar type of activity against *E. histolytica in vitro* in concentrations of 0·05 *M*; this concentration is readily attained in glucose-broth cultures of *Streptococcus fæcalis*, and removal of lactic acid from such cultures by ether-extraction almost eliminates their activity. The effect is not a direct consequence of changes in the hydrogen ion concentration of the media, though the action of lactic acid increases as the *p*H falls, and lactates, which are inactive at *p*H 7, show activity at *p*H 5. It is probable, therefore, that the principal toxic metabolite is lactic acid.

An effect was also observed *in vivo* when young rats, experimentally infected with *E. histolytica* by the method of Jones[3], were fed with living cultures of the appropriate strains of *Streptococcus fæcalis*. The degree of amœbic infection was consistently lowered, and when cultures of the two organisms were mixed before inoculation of the rats *E. histolytica* lost its infectivity within one hour.

Enterococci of the *Streptococcus fæcalis* group are normal members of the intestinal flora of man and certain animals, especially in the small intestine. Their prevalence in the colon becomes increased during the 'hurry' of the small intestine caused by diarrhœa. As a result of this, *E. histolytica* becomes more closely associated with *Streptococcus fæcalis* in the colon during the active stages of amœbiasis. It is possible, therefore, that the process described above plays a part in the natural history of an amœbic infection.

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Sex Reversal in Copepods

BETWEEN February and June 1947, 20·5 per cent of the males, 3·7 per cent of the females and 0·3 per cent of the copepodids of *Pseudocalanus elongatus* Boeck, collected from six stations between Flamborough Head and the Dogger Bank, were found to be parasitized by *Blastodinium contortum hyalinum* Chatton. Almost all the observed parasites were found to be in the tetrablastic or a later stage, with a length of 440–560 μ. They occurred singly in the vast majority of cases, but very rarely two individuals were found in the same *Pseudocalanus*. As the material was unstained, it is likely that most of the earlier stages of the parasite were overlooked, particularly in the younger stages of the copepodids, and that the proportion of infected individuals was really higher than that given.

Chatton[1] states that the presence of *Blastodinium* causes the castration of the host without, however, this affecting its external structure; on the other hand, it brings about a comparative reduction in its maximum size. He did not find any parasitized adult males, and thought that the parasite arrested the development of the last copepodid by inhibiting the final moult. Chatton recorded infection of *Pseudocalanus* sp. from the North Sea.

In the parasitized material dealt with here, while the stage V male and female copepodids and the mature females had normal external features, there were present abnormal individuals. Some of these showed a full development of the female abdomen, vulva and all other characters such as antennæ, but with the presence of a fifth pair of legs. The legs were in a state of development corresponding with that in one of the male copepodid stages. Contrary to Chatton, I have found these infected copepods to be, if anything, slightly larger than the comparable non-parasitized individuals. I have recorded to date three individuals in this category which had an attached spermatophore (Fig. 1).

I have found also several infected individuals such as that shown in Fig. 2, in which the female type of abdomen is not fully formed, showing the presence of the vulva, but with the abdominal segments 1 and 2 not completely fused together. The proportions of the remaining segments are typical of the male sex. These individuals possess, moreover, a pair of fully formed male fifth legs. The contained parasite measures about 310 μ in length and is in either the di- or triblastic stage.

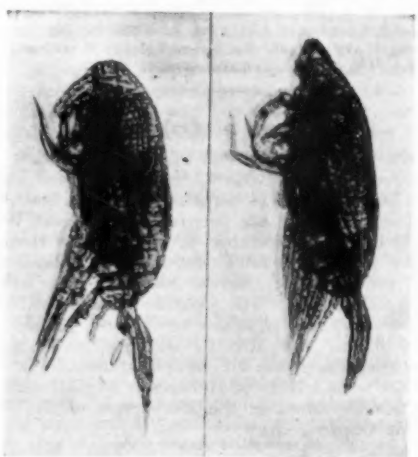

Fig. 1 Fig. 2

Pseudocalanus elongatus BOECK FROM THE SOUTHERN NORTH SEA, PARASITIZED BY *Blastodinium contortum hyalinum* CHATTON. PHOTOMICROGRAPHS OF TWO UNTREATED AND UNMOUNTED INDIVIDUALS PRESERVED IN FORMALIN. LENGTH OF CEPHALOTHORAX: FIG. 1, 950 μ; FIG. 2, 920 μ. MAG. × 40

These observations suggest that the parasite exercises no effect on the morphology of the female sex of the host, and that the last copepodid stage passes on to the fully formed but castrated individual. In the male sex, however, the parasite at some stage in its growth is able to arrest the development of the male characters of the copepodid (externally the fifth pair of legs), while in the final ecdysis it causes the copepod to undergo sex reversal and become a superficially mature but sterile female. The presence of the fifth pair of legs remaining in a state of development comparable to that in the animal's previous stage is the only indication of the original male sex.

It appears most likely that the individual of Fig. 2 became parasitized first at a later stage in its development than usual, and that it was able to reach the fully mature male stage before the parasite could exercise control over its morphology. Whether the individual could show the complete external sex change described when the parasite approaches its maximum size remains to be seen.

It is apparent that the abnormal 'females', under the influence of the parasite, have undergone complete sex reversal, for it has been shown that males find them as attractive as normal females and effect copulation (*vide* Fig. 1). The sex reversal is, however, virtual, not absolute, as according to Chatton the copepods are castrated.

Although the incidence of infection has been shown to be considerable, the castration which occurred does not seem to have caused any substantial drop in the population of *Pseudocalanus*, as large numbers of uninfected juvenile forms were found in June at the end of the period.

I am indebted to Colonel Seymour Sewell for suggesting the possible identity of my parasite and also for referring me to Chatton's paper.

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Evaluation of Herbage for Grazing

IN the numerous published accounts of digestibility trials with cut herbage, the assumption has been made[1] that the herbage fed represents that which grazing animals would eat. It is known, however, that animals select grass and clover leaf in preference to stem when grazing[2,3]; these are the more nutritious constituents of the sward, so that by feeding the whole cut from the sward, the nutritive value of the portion stock would eat in the field is underestimated. Thus we need to measure the feeding value of a portion of the sward that we cannot actually analyse, namely, that taken off by the grazing animal. This problem is being investigated at the Grassland Improvement Station.

During May–October 1947, fæces were collected daily from a group of sheep on rotational grazing, and analysed for dry matter, nitrogen and ash.

Fæcal dry matter figures from these sheep indicated that the amount of the daily feed intake was almost independent of the grazing available, but increased steadily with increase of body size. This was at variance with consumption estimated by a mowing machine technique (sampling grazed and protected areas of the sward) which appeared proportional to the amount of feed available[4]. This is because, especially when keep is short, stock obtain much of their feed below the level at which most mowing machines can cut. At times when much growth was available, the mowing machine over-estimated consumption, due to the protected sward growing more rapidly than the grazed sward[5]. The results of these experiments suggest that the usual mowing machine techniques at present used by agronomists may be valueless as methods of measuring with precision the herbage consumed by the grazing animal.

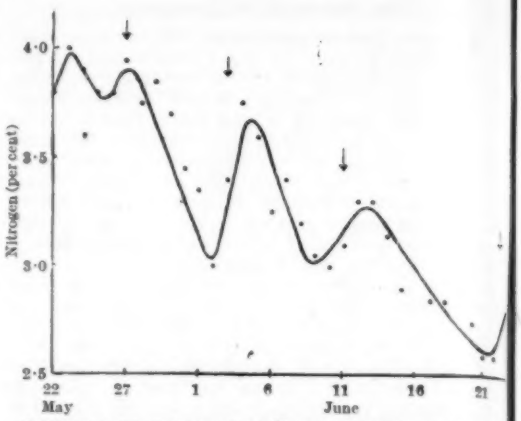
Results of experiments in which mown herbage was fed to sheep in cages[6], together with those from a large number of similar experiments, conducted at Jealott's Hill Research Station[7], have shown the following relation between the nitrogen content of the dry matter of grass fed and of the oven-dried fæces produced :

$$\text{per cent N in feed} = 0{\cdot}795 \times \text{per cent N in ash-free fæces} + 0{\cdot}14 \quad (t = 17).$$

The grass fed varied from that cut for hay or silage to closely grazed pasture grass; but different constants may apply for other feeds such as lucerne, mountain pasturage, etc.

Considering the process of selective grazing by sheep, it is likely that, day by day, the nitrogen content of their feed from a single plot will decrease, because they are progressively removing the leafiest, nitrogen-rich growth available, and leaving the stemmy part of the growth for subsequent grazing. A move to fresh herbage will make feed of higher nitrogen content available, and the nitrogen in the feed should thus exhibit a periodicity with movement from plot to plot. If, as is suggested by the regression formula given above, the fæcal nitrogen bears a direct relationship to feed nitrogen, the former should show a similar periodicity, with the time-lag of approximately two days normally assumed for the feed to pass through the gut. Analysis of the daily fæcal nitrogen from the grazing sheep has shown this to be so (see accompanying graph) and suggests that in fact the nitrogen content of fodder grazed from one plot does decrease day by day. As the nutritive value of herbage is roughly proportional to its nitrogen content[8], the feeding value of the grazing on this plot decreases daily, and the average percentage starch equivalent depends on the overall intensity of grazing.

Thus the fæcal nitrogen from grazing sheep gives a figure for nitrogen in feed grazed which is probably more accurate than that obtained by analysis of cut herbage. Experiments are now in progress at this Station to find whether analysis of fæces for other constituents (for example, lignin, as suggested by Maynard *et al.*[9], but making due allowance for the factor of selective grazing) together with nitrogen estimations will give a direct measure of the quality of the feed intake. Such analyses could be made on fæces collected from the sward, and need not demand the harnessing of stock. If it is confirmed that the main factor controlling dry matter intake is bodyweight, then we should have available a method for measuring the daily intake of nutrients by the grazing animal.



AVERAGE DAILY PERCENTAGE OF N IN ASH-FREE FÆCES FROM TEN SHEEP ON ROTATIONAL GRAZING. ARROWS MARK DAY OF ENTRY OF STOCK ON TO A NEW PADDOCK: THE EFFECT OF INCREASING MATURITY OF HERBAGE DURING THE PERIOD IS SHOWN BY LOWER FÆCAL-N FIGURES ON THE LATER PADDOCKS

I should like to thank Mr. W. S. Ferguson for permission to use figures from the Jealott's Hill experiments and my colleagues at this Station for their considerable help in the present investigations.

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Perithecia of Oak Mildew

Formation of perithecia of the oak mildew is a rare occurrence in Britain, the only record known to me being that of Robertson and Macfarlane[1], who found one leaf with six perithecia at Bricket Wood, Hertfordshire, on October 6, 1945. It is therefore of some interest to note that a few perithecia were found on leaves of *Quercus robur* at Aberystwyth on October 2, 1947. The identification of the fungus as *Microsphæra alphitoides* Griff. and Maubl. was kindly made by Mr. S. J. Hughes, Imperial Mycological Institute, who compared the Aberystwyth material with a slide of Robertson and Macfarlane's specimen deposited in the Herbarium of the Royal Botanic Gardens, Kew.

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March 12.

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RIBOFLAVIN ENHANCEMENT OF RADIOACTIVE PHOSPHATE EXCHANGE BY YEASTS

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IT has recently been suggested by von Hevesy[1] that processes occurring at the cell surfaces or just inside cell boundaries play an important part in phosphorus metabolism in yeast. We have obtained evidence that we interpret in a similar vein, and suggest the existence of a 'P-complexing factor' at the cell surface.

We have found it possible to increase the radioactive phosphate (P^{32}) exchanged by yeast in the presence of glucose by the addition of trace amounts of riboflavin to the suspending medium. The increases observed range from 20 to 200 per cent over the phosphate exchanged by controls in glucose alone. This effect has been found in two widely different species of yeasts.

The organisms used were *Candida albicans*, a pathogenic non-sporulating yeast, and *Saccharomyces cerevisiæ* (Carlsberg No. 237). Cells were grown in wort or in a medium (*GGY*) consisting of: glucose, 2·0 gm.; glycine, 1·0 gm.; yeast extract ('Difco'), 0·1 gm.; and distilled water, 100 ml., and incubated for 24 hours at 20° C. with constant agitation. The yeast crop was harvested by centrifugation, washed twice with glass-distilled water, and suspended in glass-distilled water to a known density. The P^{32} was usually introduced at this time. Aliquots of the suspension were placed in flasks (with a fritted glass aeration tube leading to the bottom of the flask) in the following medium: yeast suspension, *M*/5,000 potassium dihydrogen phosphate, *M*/15 glucose, water or riboflavin (50 μgm./c.c.). The flasks were aerated with washed and filtered compressed air, or with 95 per cent nitrogen with 5 per cent carbon dioxide (passed through a heated copper coil). After the experimental period, the yeast cells were removed by centrifugation, washed twice with glass-distilled water and the yeast cream placed in aluminium dishes adapted for Geiger–Müller counting, and measured automatically[2]. The results obtained in the two experiments reported here are typical of those we have obtained in many other experiments.

Addition of riboflavin (1 μgm./c.c. final concentration) to suspensions of *Saccharomyces cerevisiæ* or *Candida albicans* metabolizing glucose aerobically or anaerobically prompted a marked increase in P^{32} exchange. As shown in Table 1, this addition of riboflavin more than doubled the P^{32} exchanged aerobically by *S. cerevisiæ* with either glucose or sucrose as source of carbohydrate. In the same experiment, 2,4 dinitrophenol in a concentration of 10^{-3} *M* inhibited P^{32} exchange approximately 40 per cent; this is in agreement with the inhibitory action of this substance on phosphate uptake by *S. cerevisiæ* reported by Hotchkiss[3].

If a P-complexing factor is formed at the cell surface, it is possible that, once formed, it might act

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† Merck Fellow of the National Research Council.

TABLE 1. *S. cerevisiæ*, GROWN AEROBICALLY IN *GGY* MEDIUM FOR 24 HR. AT 25° C.
Not starved; exposed aerobically to P^{32} at 25° C., for 5 hr. with treatments as listed (40 mgm. yeast dry wt. per vessel)

Vessel	Treatment	Counts/min./mgm. dry wt. (standard units)
1	glucose + glycine	13·6
2	sucrose + glycine	12·5
3	glucose + glycine + 2,4 dinitrophenol	7·9
4	sucrose + glycine + 2,4 dinitrophenol	7·5
5	glucose + glycine + riboflavin	30·7
6	sucrose + glycine + riboflavin	32·8

in the absence of the energy-yielding processes apparently necessary for its formation[4]. An experiment was conducted along these lines wherein *C. albicans* was incubated aerobically at 20° C. in the presence of riboflavin and glucose, then equilibrated at + 4° C. and exposed to P^{32}. Table 2 shows that the starved suspension of the yeast exchanged twice as much P^{32} as the unstarved suspension (both suspensions were prepared from the same culture of yeast). It is also seen that riboflavin prompted a nearly four-fold increase in the exchange of P^{32} by the starved cells, but was without effect on the unstarved yeast. The occurrence of phosphate exchange at a very slow rate by yeast at + 4° C. has been reported by Lindahl *et al.*[5].

TABLE 2. *C. albicans*, GROWN AEROBICALLY IN 'TULAUF' WORT AT 20° C. FOR 26 HR. WITH AGITATION.
Half the suspension not starved (stored at 4° C. for 18 hr.), the other half starved by agitating aerobically in water for 18 hours at 25° C. Both suspensions treated as below for 2½ hr. at 25° C. aerobically with constant agitation (50 mgm. yeast dry wt. per vessel), then placed at − 4° C. for 45 min. P^{32} was then added and flasks held at + 4° C. in presence of P^{32} for 5 hr. Cells separated by centrifugation and washed in the cold

Vessel	Treatment	Counts/min. (standard units)	Counts/min./mgm. dry wt.
	Cells starved		
1	glucose + riboflavin	100	2·2
2	glucose	33·2	0·6
	Not starved		
3	glucose + riboflavin	15·4	0·3
4	glucose	19·5	0·3

The increase in rate of uptake of P^{32} in the residual-phosphorus fraction (presumably metaphosphate[11]) of yeast brought about by cyanide[6] might be considered in the light of the present data on riboflavin in view of the action shown by Pett[7] for the increase in riboflavin synthesis by yeast treated with cyanide. Among the several compounds examined, yeast nucleic acid, uracil, and fructose 1,6 diphosphate proved without detectable effect on phosphorus exchange by *C. albicans* metabolizing glucose aerobically.

Yeasts are well known to be relatively rich in riboflavin, so it is rather surprising to find that added riboflavin exerts such marked effects as we have noted. An average value for the riboflavin content of baker's yeast may be taken from Pett[7] as 20–30 μgm./gm. dry wt., of which 80–90 per cent exists as bound riboflavin. In our experiments usually 30–50 mgm. dry weight of yeast was placed in each flask containing 50 ml.; thus a total of approximately 1 μgm. of riboflavin was introduced into each flask with the yeast. If all this riboflavin were to have been released from the yeast (not possible under our conditions) a concentration of 0·02 μgm. riboflavin per ml. would have resulted. The quantities of riboflavin introduced into each flask as impurities in the sugars and glycine (reagent quality,

but not especially purified) are undoubtedly minute. While some species of the genus *Candida* are known[8] to produce sufficient riboflavin on controlled low-iron media to colour the medium, we have never succeeded, using the strains of *Candida albicans* employed here, in obtaining more than very small yields of riboflavin with similar, purified, known-iron media.

While it is well known that the presence of external phosphate is not essential for the oxidation and assimilation of glucose by yeast suspensions[9], it is also known that phosphate exchange[4,6] and polymerization (as measured by the increase in basophily[11]) are dependent on the presence of external metabolizable substrate.

In view of the correlation which has been pointed out[3] between the action of 2,4 dinitrophenol on the assimilation of carbon sources by micro-organisms and its action on the uptake or exchange of inorganic phosphate by micro-organisms, it is of interest to compare the action of riboflavin with that of other agents on these two processes. Such a comparison has been made in Table 3 (references noted). It appears there is a decided 1 : 1 correlation between the processes of phosphate uptake and assimilation of carbon by micro-organisms. At the concentrations stated, the agents listed in Table 3 are without effect on the rate of aerobic or anaerobic breakdown of carbon sources. The effect noted[10] for riboflavin on assimilation was observed with the two organisms reported on in this paper. From concomitant investigations[10] on the variation in basophily of yeasts (see Wiame[11]), it is believed that the 1 : 1 correlation between assimilation and phosphate uptake results from the, possibly coupled, simultaneous polymerization by yeasts of inorganic phosphate (to polyphosphates) and of carbon sources (to carbohydrate polymers).

TABLE 3

Substance	Concentration	Assimilation of carbohydrate	Uptake or exchange of inorganic phosphate
2,4 Dinitrophenol	10^{-4} *M*	inhibited[3]	inhibited[3]
Sodium azide	10^{-4} *M*	inhibited[3]	inhibited[3,12]
Gramicidin*	40 μgm./ml.	inhibited[3]	inhibited[3]
Glucose	10^{-2} *M*	a substrate	enhanced[4,6]
Riboflavin	$2{\cdot}5 \times 10^{-6}$ *M*	enhanced[10]	enhanced

* Acting on *Staphylococci*, other agents acting on yeast.

The observation of Malm[13] that phosphate exchange by yeast is sensitive to the *p*H of the medium can be taken as evidence that a surface reaction, easily affected by external *p*H, is involved in phosphate exchange (see Myrbäck and Vasseur[14] for an extended discussion of the considerations underlying this line of reasoning). It is unlikely that phosphate enters the yeast cell in an ionized form, and it seems reasonable that phosphate is brought through the cell barrier by uniting with some 'complexing substance' existing at the cell surface. The compound of this substance with phosphate may then dissociate, or in other manner lose phosphate to the cell (possibly to coenzyme I; see Lindahl *et al.*[5]), and free 'complexing substance' to act again. From our observations we believe that such a role as postulated for the 'complexing substance' may be filled by riboflavin. Combined roles of phosphorus and hydrogen transference for trace-active substances may assume importance in considerations of *in vivo* processes.

We wish to thank Prof. Ø. Winge for facilities at the Carlsberg Laboratorium, Prof. G. Hevesy for most helpful discussion and for reading the manuscript, and Mr. K. Zerahn for his aid in carrying out the activity counts.

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FACTORS INVOLVED IN THE DEACTIVATION OF PENICILLIN SOLUTIONS BY RUBBER TUBING

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COWAN[1] in 1945 demonstrated that aqueous solutions of penicillin could lose up to 50 per cent of their antibiotic activity by simple passage through the rubber tube of a continuous-drip apparatus. These results were confirmed by Huelsbusch, Foter and Gibby[2], who showed that certain samples of both natural and synthetic rubber could inactivate completely the penicillin in solution in twenty-four hours; and also by Hughes[3], who showed that no improvement was obtained by repeated washing of the tubes before use.

At the request of the Medical Research Council through the Ministry of Supply Advisory Service on Rubber, we have been investigating this problem in the hope that we should be able to throw some light on the mechanism of inactivation and on possible methods of improving the quality of rubber supplies. The main technological details will be published elsewhere, and the purpose of this communication is to give a summary of the results relevant to medical practice.

The Effect of Compounding Ingredients and of Vulcanization. Unfortunately, none of the early workers was in a position to supply information on the compounding ingredients other than rubber which were present in the tubes which they tested. These ingredients may well represent quite a large proportion of the total weight, and as some of them are highly active substances it was thought possible that the trouble might be due to one or more of these rather than to the rubber itself. On testing singly a number of such substances, including natural rubber, sulphur, zinc oxide, stearic acid, paraffin wax and a number of accelerators of vulcanization—mercaptobenzthiazole, dibenzthiazyl disulphide, tetramethylthiuram disulphide, zinc diethyldithiocarbamate and

diphenylguanidine—no loss in penicillin potency was observed with any of these materials. However, when these ingredients were compounded together in various proportions to give products suitable for rubber tubing and then subjected to vulcanization, the resulting rubber tubes were found to be very active towards penicillin. Thus a rubber tube vulcanized with sulphur and 1·0 per cent of mercaptobenzthiazole reduced the potency of penicillin by 80 per cent in 24 hours at room temperature, and in no case was the loss less than 60 per cent in this period.

Causes of Penicillin Deactivation. It is clear from the above that the active agents in penicillin degradation by rubber must be produced during the complex chemical changes occurring during vulcanization. The major reaction which results in the cross-linking of the rubber molecules with sulphur is unlikely to leave the latter in an active form; but in the process of heating with sulphur, it is not improbable that mercaptan compounds could be produced from any non-rubber components present. This is particularly likely in the case of vulcanization accelerators, many of which decompose during vulcanization with the production of mercaptan compounds. It is known that cysteine is effective in the deactivation of penicillin, and indeed it has been suggested by Cavallito[4] and others that penicillin and other antibiotics inhibit the growth of micro-organisms by reaction with mercaptan compounds within the organism.

In the first instance, therefore, the effect of a reduction in the proportion of accelerators from 1·0 per cent to 0·1 per cent was studied. In each case a substantial corresponding reduction was achieved in the activity of the rubber towards penicillin. Thus in the case of dibenzthiazyl disulphide, the loss of potency of the penicillin was reduced from 80 to 40 per cent, while with a diphenylguanidine-accelerated mix reduction was from 74 to 20 per cent. By the omission of accelerators altogether, a still further reduction was obtained. In some cases the rubber showed no deactivating effect whatever, whereas in others varying effects up to a maximum of 20 per cent were observed.

Confirmation of this finding was obtained by the simple heating of an accelerator—in this case tetramethylthiuram disulphide—to vulcanization temperature for ten minutes. After this treatment the product was found to be highly active towards penicillin, in contrast to its initial inert behaviour. It is therefore clear that accelerators play a major part in the deactivation of penicillin by rubber, and it is clearly desirable that the amounts used should be as small as possible.

The smaller, and variable, activity of vulcanized rubbers containing no accelerator would appear to be due to the reaction of sulphur with impurities rather than with the rubber itself, as otherwise it would be difficult to explain the preparation of some mixes which are entirely inert towards penicillin. Impurities which could react to form mercaptan compounds are often present in small amounts in natural rubber in the form of the so-called 'rubber resins', and some evidence that these may play a part in penicillin deactivation was obtained by testing acetone extracts of vulcanized rubbers prepared without accelerators. Rubber resins and their reaction products with sulphur are largely soluble in this solvent whereas the rubber complex is not, and such extracts were found to be active towards penicillin in those cases in which the vulcanized rubber itself showed activity.

Methods of Minimizing the Degradation of Penicillin. It has already been shown by Yudkin and Pulvertaft[5] that vulcanized rubber is without action upon penicillin in the presence of phosphate buffer, and we have found this to be true even with the most active rubbers which we have been able to prepare. However, where the use of phosphate buffer is impracticable, the potential destructive action of mercaptans will constitute a danger in any form of vulcanized rubber, whether natural or synthetic. In studying possible methods of minimizing this effect, we have obtained some success by the use of a suitable grade of carbon black as an inert filler in the compounding of the rubber tubes. Thus, the incorporation of carbon black in an accelerated mix resulted in the rubber tube showing 27 per cent loss of penicillin potency in 24 hours, whereas an exactly similar rubber tube, containing the same volume proportion of barytes, resulted in a loss of potency of 78 per cent. Comparable results were obtained with a variety of different accelerators. The effect is due presumably to the absorption of active substances and the prevention of their migration to the surface.

The second method examined was the treatment of vulcanized rubber tubes with reagents which are active towards mercaptan groups. This aspect has not yet been studied extensively, but promising results have been obtained by treatment for a few hours with 40 per cent formaldehyde at 38° C., whereby the destructive power for penicillin of a highly active rubber tube was considerably reduced (from 91 to 68 per cent loss of potency in 24 hours). Similar results have been obtained on a variety of different mixes, suggesting that this method of treatment would be worthy of further study, while at the same time lending some support to the view that it is the mercaptan groupings in the vulcanizate which are the active principles concerned in the destruction of penicillin.

Effect of Repeated Sterilization and of Ageing. Small chemical entities such as simple mercaptans are known to migrate to the rubber surface. This suggested a danger that the destructive power of rubber for penicillin would increase with age, and this aspect has also been examined. No alteration in the deactivating power of rubber tubes could be observed by repeated sterilization; but tubes which have been subjected to normal storage for a period of six months were found to show a marked increase in their activity towards penicillin. These tubes were deliberately prepared without the usual antioxidant in order to accelerate any effects due to ageing; but this finding does suggest the desirability of occasional checks upon rubber tubing during its period of use or storage.

Alternative Materials. In view of the obvious difficulties in the preparation of rubber tubes which can be relied upon to be completely without action upon penicillin, we have investigated the effect of a number of alternative materials. Of those which we have studied, polyvinyl chloride, with the plasticizers normally used in its manufacture, and polyethylene, have no action whatever upon penicillin. Polyethylene has the disadvantage that it shows a tendency to kink when used in long lengths, and both materials present difficulties in sterilization as their softening points are below the temperature of the normal steam autoclave. However, polyvinyl

chloride can be made in a form resistant to boiling water and is already finding uses in surgery, so that it may prove to be superior to rubber for the purpose of the drip-feed injection of penicillin.

We wish to thank the Chief Scientific Officer, Ministry of Supply, for permission to publish this communication.

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LONDON'S TRANSPORT SYSTEM

THE fourteenth annual report, recently issued by the London Passenger Transport Board, makes interesting reading. Since the undertaking is now vested in the British Transport Commission, this is the Board's final report, and it has therefore devoted one section to a review of the way in which it has discharged its functions since July 1933.

Here is an example of the operation of a very large centralized concern run on lines similar, from many points of view, to those which must be adopted in the even larger organisation of nationalized industries or utilities. There can be no doubt that in this instance the arrangement has proved in most ways an outstanding success: the Board has, in the main, achieved its object of providing "a passenger transport service, by rail and road, worthy of London as a great metropolitan city". Few Londoners would deny this: it is not so certain that the inhabitants of some other capital cities would be equally enthusiastic about the transport facilities available to them.

The magnitude of the Board's achievement can better be appreciated by reference to some of the figures contained in the report. The area served covers some 2,000 square miles, with a population in 1933 of 9,358,000. One of the first tasks was to rationalize the unrelated and often wasteful competitive services operated by the many transferred undertakings. During the pre-war years the number of vehicles owned rose from 11,753 to 12,819, and the annual mileage run by them increased from 515 to 573 million miles, providing more than nine million passenger journeys a day in 1933 and ten million in 1939—the usual calculation indicates that if the tickets issued daily were placed end to end they would stretch from London to New York. The receipts from fares rose concurrently from about 27 million pounds to nearly 31 million pounds sterling a year. While this expansion was in progress, the many types of buses and coaches were being replaced by standard designs, the maintenance system was overhauled, new equipment was introduced to increase reliability and efficiency and, most important of all, a vast programme of new works was undertaken in conjunction with the 'main line' railway companies

The outbreak of war caused a great setback to this steady growth. As a result of evacuation, the 'blackout' and bombing, the volume of traffic was so reduced that the system ceased to be self-supporting. But after 1941, traffic again increased and reached a peak of 4,259 million journeys in 1946, totalling 11,479 million passenger miles. The number of journeys made per head of population per year is a measure of the 'travel habit'; this figure rose from just over 100 before the War to nearly 130 in 1946, which certainly indicates no reluctance on the part of the public to travel.

Mention may be made of some of the technical innovations originating with the Board. In 1938 re-designed rolling stock was introduced on the 'underground' railways, the electric motors being installed beneath the floors of the carriages. This eliminated the waste of one car in a seven-car train to house the power plant, and thus gave a 14 per cent increase in carrying capacity. The Board was among the first to recognize the advantages of the oil engine as compared with the petrol engine from the point of view both of performance and of economy in operation and maintenance. It accordingly adopted the oil engine from 1934 onwards as the standard power unit for all new buses and coaches. It was also a pioneer in the large-scale use of the pre-selective gear box and fluid flywheel transmission, which not only ease the work of the driver but also materially increase the comfort of passengers by virtue of the smoother running which they give. Before the War, the trams on many routes were replaced by trolleybuses; but since the War the financial advantage of the trolleybus has decreased to such an extent that further conversion of tramways will be to buses, which are more flexible in operation and offer wider opportunities for co-ordination of all services provided by the use of a single type of road vehicle. Another remarkably successful innovation of the Board was the novel constructional technique employed on the eastern extension of the Central Line.

The first regular passenger service in London was established in 1829, and during the succeeding century development proceeded under a multiplicity of private operators. The extraordinary complexity of the resulting system makes it difficult to offer a fair criticism of the Board's efforts, though it would appear that there is room for immediate improvement in certain directions: the rationalization of routes in the central area and, in particular, the links between the 'main line' railway stations require attention. It is, for example, impossible to get from King's Cross to Victoria station without at least one change, apart from the interstation buses which are so infrequent and circuitous in route as to be virtually useless.

The report concludes with a reference to future prospects and deplores the lack of materials and national restrictions which have prevented a more rapid recovery from the effects of war. It has been argued, however, that the present difficulties are attributable, at least in part, to the policy pursued before the War of scrapping vehicles when the body was worn out, instead of retaining the chassis with a new body and an oil engine; this criticism applies particularly to the 'ST' type of motor-bus. But the Board would probably be the first to admit that errors of judgment have occasionally been made and to acknowledge that the traffic system is still capable of much improvement.

Though the layman may occasionally wonder at some of the oddities of the system—what purpose is served, for example, by the posters informing us that London's transport is at our service when no other means of travel is available, and why does the hand-rail always travel slower than the escalator?—the Board is to be congratulated on furnishing an example of the efficiency which should be attained by all public undertakings.

R. H. MACMILLAN

RADIO RESEARCH IN BRITAIN

A REPORT from the Research Committee of the Institution of Electrical Engineers under the title "British Research in the Radio Field" has been published recently by the Institution*.

While the report includes a general review of the existing facilities for radio research in Great Britain and makes some assessment of the scale of effort involved, it is primarily directed towards considering the means whereby research may be still more actively and effectively pursued and better co-ordinated. The view is expressed that the present volume of radio research is inadequate to maintain, in the face of intensified international competition, a progressive and flourishing radio industry.

Recognizing the difficulty, when describing research in relation to industry, of differentiating sharply between research and development, the report gives a broad general classification under the three headings: (1) basic or fundamental research; (2) applied research or advanced development; (3) development and design.

Attention has been concentrated, in the main, on work considered to fall in the first and second categories; but the vital importance to industry of first-class engineering development is also emphasized.

In analysing the distribution of research activity, sub-division is again made under three headings, namely: (*a*) academic research; (*b*) research by Government establishments, Department of Scientific and Industrial Research and B.B.C.; (*c*) industrial research.

An interesting comparison is made, in tabular form, of the distribution of the existing capacity and facilities devoted, in these spheres, to various main branches of radio research.

The conclusions and recommendations of the report are the consequences, direct and indirect, of the acceptance as a basic principle that "successful research is more dependent on the qualities, character and inspiration of the research team leaders than on any other factor governing its conduct".

In a paragraph entitled "Research Leaders", it is asserted that "The key to the expansion of research in the radio field, as in all others, lies in the discovery and encouragement of the limited group of men who are competent to act as team leaders and who possess the intellectual and personal qualities which have always proved essential for the successful pioneering of research".

The position of the universities in relation to what may be termed research potential is considered to be a central one on the ground that, not only do the universities, and to a lesser extent the technical colleges, make a very material direct contribution of original research, but also it is through their teaching activities, both undergraduate and postgraduate, that the supply of potential research workers is maintained. Fairly detailed consideration is given to the factors governing the effective pursuit of research and postgraduate study in the universities of Britain, and it is suggested that many of the considerations affecting academic research apply with equal force in relation to industrial research.

In regard to finance, the existing mechanism, whereby official support comes through the University Grants Committee and through the Department of Scientific and Industrial Research, is regarded as satisfactory; but it is emphasized that an expanded postgraduate programme necessitates increased funds from these sources. It is, however, reiterated that an essential requirement in university research is freedom of action in the development of the research programme.

In relation to the staffing of university research projects, attention is directed to the importance of maintaining, through the work of permanent members of the staff, continuity and integration of effort among postgraduate student members of research teams; and, in a similar connexion, to the necessity for attracting and retaining in university laboratories adequate numbers of well-qualified laboratory assistants, technicians and craftsmen.

The postgraduate university research worker may vary in age and qualification from the relatively senior holder of a major research fellowship or scholarship to the young graduate of a few months standing. Improved financial provision is regarded as necessary for the important group that returns to the university after two or three years in industry. With regard to the young graduate class, it is recommended that a period of at least six months be spent in industry before taking up academic research.

A considerable part of the report is devoted to the question of the co-ordination of research in the radio field. A primary aim must be the early dissemination of results as widely as possible. Suggestions are made for the improvement of the existing mechanism by the use of an organisation resembling the Central Radio Bureau to collect and circulate information on researches in progress, thereby minimizing the delay which inevitably exists in the publication of completed research through the normal channels. In the field of basic research in the universities, it is considered that co-ordination of effort to a desirable degree can be better achieved by the efficient exchange of current information than by positive co-ordinative action which might take on a restrictive character.

With reference to research in Government establishments, the report welcomes the recent setting up under the ægis of the Department of Scientific and Industrial Research of a Committee on Fundamental Research in Telecommunications, and suggests that a broadening of the terms of reference of this Committee and its establishment on a permanent basis would serve to co-ordinate effectively the main body of research in this sphere. It is further suggested that an effort should be made to maintain something of the co-operation obtained during the War by the Inter-Services Radio Components Research and Development Committee which operated under the Ministry of Supply.

An important example of large-scale technical co-ordination in the telecommunications field is the work of the British Telephone Technical Development Committee, which, under the chairmanship of an assistant engineer-in-chief of the Post Office, achieves the co-operation of the main telephone manufacturing companies in Britain in technical development so that individual research effort is fostered, but also, by the pooling of inventions, a unified development policy for the telecommunications system as a whole is ensured.

Probably the statement of the greatest practical significance, not only in the field of radio communications but also in other subjects, which the document

* British Research in the Radio Field: a Report from the Research Committee of the Institution. Pp. 20. (London: Institution of Electrical Engineers, 1947.) 1*s*. Also *J. Inst. Elect. Eng.*, **94**, Pt. 1, 502 (Nov. 1947).

contains is the following: "The Panel have been impressed by the opinion consistently advanced by the University representatives who have attended the meetings that among their graduates those suited to a research career form but a small proportion of the whole; the remainder, while fully competent to absorb and profit by the scientific and technical curriculum, appear to lack those powers of patient and deep-seated inquiry which characterize the natural research worker and lead him to expose new truths".

Such a conclusion emphasizes the duty of all in industry, research establishments or universities who have the opportunity of discovering real research ability to be vigilant for its occurrence and assiduous in its nurture. J. GREIG

THE BRITISH COUNCIL

ANNUAL REPORT

THE annual report of the British Council for the year ended March 31, 1947, only became available a short time ago. The report itself is preceded by an introductory re-statement of the general aims, duties and organisation of the Council, which indicates concisely but lucidly the place of the Council in explaining British cultural achievements and the background of social life, and also the broad grounds on which a grant-in-aid of about three million pounds a year is justified. Referring to the widespread demand for teaching the English language created by the War, the report records the Council's decision in principle not to engage in the direct teaching of elementary English, but to assist, in conjunction with the ministry of education of the country concerned, in improving the standard of teaching of the English language. Concluding that too much effort had in the past been concentrated on the intelligentsia and on the capital cities of foreign countries, the Council also made every effort during the year to widen its influence through contacts with workers' educational movements and with study groups in smaller towns, and it is planned to provide a number of short-term bursaries to enable trade unionists, artisans and apprentices to visit Great Britain to meet their fellows and study the conditions of work in factories, etc. At the invitation of the Commonwealth authorities, a centre was established in Australia during the year, an experiment which has been an unqualified success.

During the year, 248 new scholarships, including three senior fellowships, were awarded as compared with 307 in 1945–46, and 190 scholarships were extended. In addition, nearly two hundred private students were assisted by the Council to secure places at British universities; and vacation courses for overseas students were held at St. Andrews, Oxford and Queen Mary College, London, the last being a specialized course on high-voltage engineering. Lecture tours organised numbered 97 in 28 countries, as against 70 in 1945–46. Thirty-seven new brochures, revised editions and reprints were issued during the year, the series generally in most demand in Europe being *British Life and Thought*, *Science in Britain* and *The Arts in Britain*; in the Balkans, the Middle East, Africa and South America, *Britain Advances* and *British People* are more in demand. The Council's work in the field of copyright has now been transferred to the Central Office of Information, but the year was marked by the founding of Council libraries in many European countries and their consolidation in others. Collaboration with the Information Services of the Foreign Office towards pooling resources in joint libraries, functioning both as special reference centres on current British affairs and as Council libraries, is designed to prevent overlapping. Large exchanges of books took place with the U.S.S.R. through the Lenin Library at Moscow, and universities and other centres of Russian studies in Britain have thus received valuable material. In the Colonies, the Council is concerned mainly with assisting the development of library services generally. Two small exhibitions of scientific and medical books were sent to Norway, and an exhibition, with extensive technical and medical sections, toured widely in Switzerland, while one of scientific and technical books was shown in Brussels, Antwerp, Liège, Ghent and Louvain. Some 1,800 periodicals, covering all branches of the humanities, science, medicine and technology, were made available in 1,168 centres in eighty-five countries, and exchanges totalled 3,476, involving 791 foreign and 765 British periodicals, including 77 British Commonwealth publications. Indexes and contents lists for the war years of sixty specialist periodicals were microfilmed and 25 copies of the film distributed to Austria, Belgium, China, Czechoslovakia, Denmark, Finland, France, Greece, Netherlands, Hungary, Italy, Norway, Poland and Yugoslavia, while in Europe 67 universities and specialist libraries in 15 countries were supplied with British periodicals by presentation or exchange.

Scientific workers form a large proportion of British Council visitors to Great Britain and of lecturers sponsored overseas by the Council. In collaboration with the Scientific Instrument Manufacturers' Association, under the auspices of the Academy of Engineering Science and the Swedish Association of Technical Physics, an exhibition of scientific instruments was organised in Stockholm in May–June, 1946. Assistance was given to the expedition planning to survey a large freshwater lake in Venezuela, and arrangements have been made for the exchange of biological specimens between Brazil and various museums and laboratories in Britain. Many countries have used the Science Department for effecting exchanges of material, and the Department has advised on scientific appointments overseas, scientific films and film strips and on the publication of *Science in Britain*. Production of *Science Comment* was suspended in September 1946 as it had become partly absorbed in the modified *Monthly Science News*.

The fourth volume of *British Medical Bulletin*, produced during the year in Spanish and French editions as well, has been placed on a sales basis in countries where currency and other regulations permit, and free distribution is being reduced to a minimum. Medical periodicals received by the Library from other countries, mainly in exchange for the *British Medical Bulletin*, now number more than 650, and all important British medical books as well as many foreign ones are now received for review in the *Bulletin*. The Medical Department also handled an increasing number of inquiries, mainly bibliographical, and supplied many reprints and Photostat copies of articles in response to requests from abroad. Advice was given on questions of technical education and postgraduate training in Britain to 93 overseas studies from thirty countries, ranging over some twenty branches of engineering and science, and advice was also given on numerous agricultural subjects.

PLANT VIRUS DISEASES

FOUR recent papers from the Rothamsted Experimental Station contribute to our knowledge of virus in the pure state and in the infected cell, and also to etiology. E. M. Crook and F. M. L. Sheffield (*Brit. J. Exp. Path.*, **27**, 328; 1946) have examined purified tobacco mosaic virus under the electron microscope. Particles from the slowly sedimenting fraction are almost spherical; but as the sedimentation-rate increases, particle-length increases. Treatment with phosphate and varying conditions of storage further affect the state of aggregation. Potato virus X also has particles of variable length.

N. W. Pirie (Cold Spring Harbor Symposia on Quantitative Biology, **11**, 184) discusses the state of viruses in the infected cell. In a fully documented account, he examines the possibilities that (*a*) the virus particle may form a complex with components of normal tissue, and (*b*) properties of the virus might be altered by the process of isolation. There must also be virus in a 'free' state, and it may be the properties of this phase which have hitherto been assessed. The influence of light intensity on the susceptibility of plants to certain virus diseases has been investigated by F. C. Bawden and F. M. Roberts (*Ann. App. Biol.*, **34**, No. 2, 286; May 1947). Reduction of summer light-intensity to one third increased their susceptibility to infection with tobacco necrosis, tomato bushy stunt, tobacco mosaic and tobacco aucuba mosaic. Shading increased the number of local lesions and the amount of virus in extracted sap and also of systemically infected leaves. Virus from leaves grown in reduced light is also superior for purification studies. The virus of tobacco necrosis has been found by F. C. Bawden and B. Kassanis (*Ann. App. Biol.*, **34**, No. 1, 127; Feb. 1947) to enter plants of *Primula obconica* and to multiply locally; most of the tissues are free from virus. This is in contrast to the systemic infection by most viruses.

I. W. Selman, reporting work at the Cheshunt Experiment Station, has also found (*J. Pom. and Hort. Sci.*, **22**, Nos. 3 and 4, 226; Dec. 1946) that tobacco and yellow mosaic viruses may, under certain conditions, become localized in developing fruits of the tomato for an indefinite period, without the virus infection being completely systemic. The same author has studied the effect of seven different base fertilizer treatments and two levels of watering on resistance of fruiting tomato plants to infection with yellow mosaic (*J. Pom. and Hort. Sci.*, **23**, Nos. 1 and 2, 71; Sept. 1947). Varying the manures had no effect, but over-watering decreased the resistance of plants to systemic invasion by the virus. On the dry border, however, the best result was obtained in one experiment in which only five plants developed systemic infection out of sixteen inoculated. Little critical work has been done on the general question of the growth of a plant in relation to virus infection, but a useful survey of the literature, still by the same author (*ibid.*, *J. Pom. and Hort. Sci.*, **23**, Nos. 1 and 2, 50; Sept. 1947), indicates that studies on these lines may lead to useful control of viruses in practice.

Bulletin 196, Council for Scientific and Industrial Research of Australia (Melbourne, 1946), by J. G. Bald, D. O. Norris and G. A. H. Helson, deals with aphid populations, resistance and tolerance of potato varieties to leaf roll. The aphids *Myzus persicæ* and *Macrosiphum gei* were studied as vectors. There were indications that the stage of development of the potato plant influenced the preferences of both species of aphid. Indeed, the latter species had no preference for diseased Up-to-Date potato plants if leaf-roll had caused severe stunting. Several varieties of potato have been evaluated for their tolerance or susceptibility to leaf roll, but the degree of tolerance is not always reflected in yield.

EDUCATION IN GUATEMALA

IN 1943 the U.S. Office of Education undertook the preparation of a series of basic studies on education in a number of Central and South American countries under the sponsorship of the Interdepartmental Committee on Scientific and Cultural Co-operation. The studies were begun to promote understanding of educational conditions in the American countries and to encourage co-operation in the field of inter-American education. "Education in Guatemala" is based on data gathered by Cameron D. Ebaugh in 1944 and 1945 and supplemented since by documentary study. Published in 1947, exactly a hundred years after Guatemala became a republic, this well-documented account of the state of education in the second largest and most populous of the Central American republics shows how the original method of education by religious indoctrination to limited numbers is now slowly giving way to a system of liberal education for all (Washington, D.C.: Gov. Printing Office).

Instruction by religious orders on organised lines was begun many centuries ago, and a *colegio* to offer education at the secondary school level was founded by a religious order so long ago as 1573. Schools of this type were generally open to the sons of peninsular and, later, of American-born Spaniards, the native Indians seldom being granted admission. In 1676 a university was authorized by royal mandate for the teaching of theology, law and medicine and the conferring of the degrees of bachelor, master, licentiate and doctor. The new institution was given the same scholastic standing as the University of Mexico and in 1875 became the National University of Guatemala; in 1945 it was made autonomous and its name was changed to the Universidad de San Carlos de Guatemala. To-day it is regarded as the most advanced and popular institution of higher learning in Central America.

Education in Guatemala continued largely in the hands of the church until the revolution of 1871. In that year, education was declared the right of all citizens, regardless of caste, creed, age or sex. Many elementary schools and a number of secondary schools were founded by the Government, many of them in former convents. Lay teachers were appointed and curricula devised on lines closely similar to those of Western European Countries. In 1875 the Organic Law of Public Education made public elementary education universal and uniform in organisation, administration and supervision. From that time Guatemala has provided compulsory, free and non-secular instruction at the elementary school level. Because of the lack of school buildings and teachers, however, compulsory education has not been widely enforced. To-day, of the population of 3,407,444, about 70 per cent are still illiterate. As in other Latin American republics, education in Guatemala is highly centralized and administration, organisation and supervision are controlled through the Ministry of Public Education in Guatemala City; the University of San Carlos is alone autonomous.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 14

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. C. S. Collins: "Expansion Engines for Helium Liquefaction and Oxygen Production".

Monday, June 14—Saturday, June 19

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (in the Town Hall, Great Yarmouth).—Fifty-second Annual Congress.

Tuesday, June 15

At 8 p.m.—Mrs. Jacquetta Hawkes: "Archæology and the Present" (Presidential Address).

Tuesday, June 15

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. C. E. V. Leser: "Industrial Productivity in England and Scotland".

Wednesday, June 16

GEOLOGICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Philip H. Kuenen: "Slumping in the Carboniferous Rocks of Pembrokeshire"; Prof. Alan Wood: "The Structure of the Wall of the Test in the Foraminifera".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Capt. C. E. N. Frankcom: "The Operation of Ocean Weather Ships"; Discussion on "Optical Properties of the Atmosphere" (to be opened by Mr. James Paton).

Wednesday, June 16—Friday, June 18

ILLUMINATING ENGINEERING SOCIETY (at the Royal Hall, Harrogate).—Summer Meeting.

Thursday, June 17

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Analogues of Growth Factors in relation to Antibiotics" (to be opened by Sir Paul Fildes, F.R.S.).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Jack Spalding: "Impressions of Mining Practice in North America".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. L. S. Bosanquet, Mr. A. E. Ingham, F.R.S., and Prof. E. C. Titchmarsh, F.R.S.: "Some Aspects of the Work of G. H. Hardy".

INSTITUTE OF SOCIOLOGY (at Kingsway Hall, Kingsway, London, W.C.2), at 5.30 p.m.—Mr. Leslie Paul: "Personalism and Humanism"; Mr. Gordon Rattray Taylor: "The Nature of an Organic Society".

UNIVERSITY OF LONDON (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. H. A. Innis: "The Press—a Neglected Factor in Economic Development since 1900" (Stamp Memorial Lecture).*

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual General Meeting; Prof. M. Erfan: "Pulmonary Bilharziasis".

Friday, June 18

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TECHNICAL AUTHORS under the Ministry of Supply for the preparation of technical publications on aircraft and associated equipment used by the Royal Air Force and Royal Navy—The Ministry of Labour and National Service, London Appointments Office, 1–6 Tavistock Square, London, W.C.1, quoting K.U.261 (June 19).

JUNIOR LABORATORY ASSISTANT (female) for animal work—The Head of the Nutrition Department, College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1 (June 19).

CHAIR OF PHILOSOPHY in the Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 20).

LECTURER IN PHILOSOPHY—The Registrar, University College, Southampton (June 22).

GAS LIGHT AND COKE COMPANY RESEARCH FELLOWSHIP IN GASEOUS FUEL AND COMBUSTION—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 24).

LECTURER IN TAXONOMIC BOTANY—The Secretary, The University, Edmund Street, Birmingham 3 (June 26).

SEWAGE RESEARCH CHEMIST—The Town Clerk, Town Hall, Bradford (June 28).

CHAIR OF VETERINARY PATHOLOGY—The Registrar, The University, Liverpool (June 28).

LECTURERS IN PHYSICAL CHEMISTRY, PURE MATHEMATICS, BOTANY, AGRICULTURAL CHEMISTRY, and AGRICULTURAL ZOOLOGY, at the Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (June 30).

LECTURER and a JUNIOR LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN PURE MATHEMATICS, at the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 30).

DEWAR RESEARCH FELLOWSHIP tenable in the Davy Faraday Research Laboratory—The General Secretary, Royal Institution, 21 Albemarle Street, London, W.1 (June 30).

HEAD OF THE SHEEP SECTION of the Department of Applied Nutrition—The Secretary, Rowett Research Institute, Bucksburn, Aberdeen (June 30).

SENIOR ENTOMOLOGIST, and JUNIOR ENTOMOLOGISTS (2), IN THE DEPARTMENT OF AGRICULTURE AND LANDS, Government of Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (June 30).

ENGINEER (Experimental Officer or Senior Experimental Officer), a PHYSICIST (Experimental Officer), and a PHYSICIST (Assistant Experimental Officer), at the Chemical Defence Experimental Establishment, Ministry of Supply, for work in connexion with insecticide research and development—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (June 30).

READERSHIP IN BACTERIOLOGY at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 5).

RESEARCH OFFICER (Cement and Ceramics) IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1524 (July 5).

LECTURER IN SURVEYING to work under the direction of the Professor of Surveying and Photogrammetry—The Secretary, University College, Gower Street, London, W.C.1 (July 23).

PROFESSOR AND HEAD OF THE DEPARTMENT OF AERONAUTICAL ENGINEERING, and a PROFESSOR AND HEAD OF THE DEPARTMENT OF INTERNAL COMBUSTION ENGINEERING, in the Indian Institute of Science, Bangalore—The High Commissioner for India, India House, Aldwych, London, W.C.2 (Bangalore, July 31).

METALLURGISTS (*a*) to undertake research and development on problems concerning the properties and treatments of steels, (*b*) to investigate problems concerning the applications of steels; CHEMISTS and ASSISTANTS (Ref. 'Corrosion') for the development of methods of combating the corrosion of iron and steel; and a PHYSICAL CHEMIST (Ref. 'Steel Making') to study problems in connexion with the physical chemistry of steel-making—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting the appropriate Reference.

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Nottingham.

LABORATORY ASSISTANT (male or female) to work in a metallurgical research laboratory—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Metallurgical Laboratory'.

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING AND PHYSICS—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

RESEARCH CHEMIST—The Director of Research, Research Association of British Flour-Millers, Cereals Research Station, St. Albans.

SENIOR TECHNOLOGICAL CHEMIST, JUNIOR RESEARCH CHEMISTS, a JUNIOR RESEARCH PHYSICIST, and a JUNIOR GRADUATE IN PHYSICS, ENGINEERING or CHEMISTRY—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

LABORATORY ASSISTANT (Grade II) FOR PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

SENIOR TECHNICIAN in charge of special Histological Laboratory, National Hospital—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

CHIEF ENGINEER, an ELECTRICAL ENGINEER, and a CHEMICAL ENGINEER, in the Pakistan Ordnance Department—The Army Technical Liaison Officer, High Commissioner for Pakistan, 16 Pinshardinge Street, London, W.1.

GEOLOGIST on the Geological Survey of the Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Geologist'.

FIELD OVERSEER in a Research Unit proceeding to Mauritius to undertake a large-scale mosquito eradication experiment using D.D.T. and B.H.C. insecticides—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Committee of Privy Council for Medical Research. Medical Research in War. Report of the Medical Research Council for the Years 1939–45. (Cmd. 7335.) Pp. 455. (London: H.M. Stationery Office, 1948.) 7s. 6d. net. [35

British Intelligence Objectives Sub-Committee. Overall Report, No. 4: The Glass Industry of Germany during the Period 1939–1945. By Prof. H. Moore. Pp. 12. (London: H.M. Stationery Office, 1948.) 4d. net. [45

Other Countries

Institut de France: Académie des Sciences. Annuaire pour 1948. (No. 31.) Pp. 236. (Paris: Libr. Gauthier-Villars, 1948.) [35

Publications scientifiques et techniques du Ministère de l'Air. No. 209: Sur les vibrations de certains systèmes élastiques dans un champ sonore. Par Dr. Théodore Vogel. Pp. iv + 80. (Paris: Service de Documentation et d'Information technique, 1948.) 220 francs. [35